Established 1832.

# THE RAILROAD AND ENGINEERING JOURNAL.

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## VOLUME LXV.

[VOLUME V, NEW SERIES.]

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### (VOLUME V, NEW SERIES.)

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(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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OUR supply of copies of the RAILROAD AND ENGINEERING JOURNAL for June, 1888, is entirely exhausted. As we need a few, any subscriber who may have a copy of that date, and who does not preserve his files, will confer a favor upon the JOURNAL by sending it to the office. For any copy of that issue sent in, the sender will receive a credit of *two months* on his current subscription.

THE publication of the next article in the series on Practical Railroad Information is necessarily postponed until the February number of the JOURNAL, owing to the fact that its preparation required an extended series of experiments and the use of some testing apparatus made especially for this purpose, which could not be completed in time for the present number.

The value claimed for this series is that it presents facts obtained by careful tests and long experience; and its authors desire to exercise the utmost care in basing their deductions entirely upon such facts. That this, in the present case, involves some delay could not be avoided, and our readers will have the full benefit of the longer time necessary for preparation.

THE removal of the Grant Locomotive Works from Paterson and their establishment on an enlarged scale at Chicago are notable events in their way. A number of engines have been built in railroad shops in the West; but the new Grant Works will be the first large shop building locomotives for sale which has been placed west of Pittsburgh for a number of years. To state all the causes of this would occupy too much space; but there seems to be no reason now why Chicago should not be an excellent location for the works, and it is to be hoped that they will secure there the success which there is every reason to expect for them. The new works will be provided with all the improvements in buildings and plant which long experience in the business may suggest to their owners and builders.

THE Intercontinental Railroad Commission has organized by a choice of Mr. A. J. Cassatt as President, and has begun its work at Washington. At the first meeting there were present representatives from Mexico, Guatemala, Costa Rica, Columbia, Ecuador, Venezuela, Peru, Paraguay, Brazil, and the United States. The Commission has established its headquarters at No. 1016 Vermont Avenue in Washington.

THE Commission appointed to mark out a location for the bridge over the Hudson River at New York has adopted a report indicating the point where the bridge should be built, and the lines for the approaches on the New York side and the connections with other railroads. This report is opposed, as any such location would be, by parties interested, and may not be finally approved. It is said, however, that the company will be ready to begin work as soon as the location is decided and the plans for the bridge itself receive the approval of the Secretary of War, as required by the act of Congress authorizing its construction.

The proposed structure, it will be remembered, is to have a single river span of 2,800 ft., high enough above the water to avoid interference with navigation. The general plan is that of Mr. Lindenthal, though the precise details cannot, of course, be decided on until the questions of location and height are finally settled.

Nothing has yet been definitely announced as to the financial arrangements for building the bridge. Its success will depend very much upon the railroads having their terminal stations on the west side of the Hudson. If they will unite in using it its traffic will probably pay interest upon its cost, but otherwise the return is doubtful, for it will not be so placed as to have at once an enormous local business, like the Brooklyn Bridge.

THE Obelisk in the New York Central Park, which was treated for preservation some time ago, was reported recently to be showing alarming signs of disintegration from the effects of the weather. It was, accordingly, carefully examined by a commission of experts, who have reported to the Park Commissioners that the results of the former preservative treatment were excellent, and that there is no need of any additional protection of the general surface. Certain decayed or decomposed spots exist, however, which they recommend should be further treated by the process originally used—the paraffine process—under the charge of the inventor, Mr. R. M. Caffall. The disintegration in these defective spots probably began, the experts think, before the Obelisk was brought from Egypt.

THE Navy Reports this year show another year of hard work in the extension of the Navy and in building the new

ships and guns which are required for its formation. The Secretary's report, a summary of which will be found on another page, shows what has been done already and what is in progress. The reports of the different bureaus, which are reserved for more extended notice hereafter, will show the work in detail. The Navy Department has been a very busy place for some time past, and promises to be so for some time to come.

THE latest bids for the construction of new ships were opened at the Navy Department on December 20. For the harbor defense ram—better known as the Ammen ram —the only bid was from the Bath Iron Works for $930,000, the ship to be built on the Department plans, except that she shall not be rejected if she fails to make 17 knots an hour.

For Torpedo-boat No. 2 three bids were received. The Herreshoff Company offered to build a boat of the size specified, 112 tons displacement, for $93,200, or one of 140 tons for $125,000, in either case on bidder's plans. The Cowles Engineering Company, Brooklyn, N. Y., offered to build a boat of 112 tons, on bidder's plans, for $119,940.

The contract for the torpedo-boat has not yet been awarded by the Department. That for the ram will be given to the Bath Company.

## THE SOCIETY OF CIVIL ENGINEERS ELECTION.

FOR some time past there has been more or less dissatisfaction with the management of this Society. The malcontents gave expression to their discontent in the nominations for officers to be voted for at the next annual election, which is now near at hand. The office of Secretary seems to be the chief point of attack, for which position there are a number of nominees and a good deal of wrangling. The making of nominations goes gayly on, declinations of candidates are numerous, and nearly every clique and community represented in the Society has its own ticket in the field. Legal opinions, pro and con, are quoted with reference to the eligibility of candidates, until the contemplation of the canvass suggests the campaign of Parnell in Kilkenny. One candidate has issued a circular congratulating the Society on the high standard of its membership, and the fact that it has "refrained" from doing some things and has "denied" its approval to others. There seems to be danger that in its efforts to maintain its advanced standard of membership, the more important end of doing useful and profitable work may be lost sight of. The circular referred to also says, that on account of the competition of the various Engineering Journals, which pay more or less liberally for contributions, the Society does not receive many papers that would otherwise naturally come to it. This is rather a grave charge on the members and the Society. If members who write papers prefer the lucre which they get from the Journals to the distinction attending the reading of a paper before an Association with a high standard of membership, it shows that either the members are sordid, or the value of the distinction is low.

That there is some influence in the Society which prevents it from being as useful as it should be, or is needed to make it so, has long been a subject of remark. The present campaign seems to indicate that the defect is an inability on the part of the membership to co-operate for the promotion of the professional usefulness of their organization. For twenty years the constitution has been a perpetual subject of amendment, and no abiding agreement with reference thereto could ever be reached. It is not a great while ago since a Committee of five members was appointed to draw up certain general specifications to secure the safety of iron bridges. When the Committee reported there were five distinct reports—no two members could agree, and the Society never adopted any of them. This inability to concur and work together seems to be a professional defect of civil engineers. It is due perhaps to the fact that success in their calling is not dependent to any very great extent on co-operation with other people. The same trait may be noted in college professors. Mechanical engineers, on the other hand, cultivate a capacity for co-operation, because their success is usually directly dependent upon an extensive and elaborate organization for the manufacture of more or less complicated structures. The usefulness of a manager, or a subordinate officer, of a machine shop would soon reach its end if he was unable or unwilling to concur with his co-workers.

But to return to the election. A campaign like that which has been carried on cannot be of much benefit to the Society, and seems likely to result in a loss of influence and dignity. To a great extent it is a wrangle over the office of the Secretaryship. This would be avoided in future if the Secretary, instead of being elected by a vote of the members, was appointed by the Board of Directors. This would be a benefit in many other ways. The Secretary should be the servant of and be accountable to the Board. They should have entire control of him, with the right of appointment and dismissal. They are the only parties who can know whether he is performing his duties properly or not. If he is not, the Board of Directors should have power to call him to account. A small body of men like the Board would also be much more likely to select a person competent for the position than a nominating caucus will. The Secretaryship is the only salaried office in the Society. It therefore becomes a more or less desirable position to attain to, and there is always the risk that the election may be attended by a discreditable canvass, like the present one. If the Secretary was appointed he would also feel more independent than he can if his name must be submitted annually to the approval of the whole membership, who cannot possibly know what his qualifications are, or how he has performed the duties of his office. His election is a constant temptation to the acquisition of influence over the membership, to strengthen him in the position he occupies. His duties, the control of the correspondence, and other influences, can all be used by him to this end. If he was appointed there would be no occasion to use such arts to make his occupancy of the office secure.

In the Master Car-Builders' Association the Secretary has been appointed instead of elected for the past eight or ten years, and with the result that the method of appointing him has avoided all electioneering and intrigue to secure the position. The clause of the constitution under which he is appointed is as follows:

"A Secretary, who may or may not be a member of the Association, shall be appointed by a majority of the Executive Committee at its first meeting after the annual election, or as soon thereafter as the votes of a majority of the members of the Executive Committee can be secured for a candidate. The term of office of the Secretary thus ap-

pointed, unless terminated sooner, shall cease at the first meeting after the next annual election succeeding his appointment, of the Executive Committee organized for the transaction of business. Two-thirds of the members of the Executive Committee shall, however, have power to remove the Secretary at any time. His compensation, if any, shall be fixed for the time that he holds office by a majority of the Executive Committee."

If the Society of Civil Engineers would adopt this method of appointing, instead of electing, their Secretary, it would be sure to secure more efficient service in that office and avoid in future the discredit of a canvass like the one now going on.

## JOHN ERICSSON.

*The Life of John Ericsson: by Walter Conant Church.* 2 volumes, illustrated. (New York; Charles Scribner's Sons.)

John Ericsson was so great an engineer, and was so completely identified with the progress of engineering during his lifetime; was, in fact, in himself so large a factor in that progress, that it would be entirely out of place here to enlarge upon this point. He was so peculiar in his life and methods of work, that while most engineers fully recognized his greatness, while many respected his authority as a master, and some were, in one way or another, brought into contact with him, very few knew him well personally, and his private and individual life was almost a sealed book to the world. What he accomplished is on record, but how he did it and by what processes he reached his conclusions very few knew.

In writing his life Colonel Church had the advantage of long personal intimacy, and of full access to the papers and letters, granted him at Captain Ericsson's own request. He has made liberal use of these in the work, sometimes in a very interesting way, sometimes, it must be said, in a less artistic manner. The great fault of the book is a tendency to too great minuteness in some points, while others are left with what appears to the reader too little explanation. On the whole, however, it is an exceedingly interesting book, and not only tells the story of his great achievements, but also gives us some idea of what Ericsson the man really was like.

The secret of Captain Ericsson's wonderful success was in his clear perception of principles, his mastery of details, his fertility of resources, and his untiring industry and extraordinary capacity for work. His mind was wonderfully acute, and he could see at once a point which most men could reach only by long study. He had also a great power of expressing his ideas, and could convey them to others with ease. Probably he has never been excelled as a draftsman, and his mastery of that universal language of mechanics was of the greatest possible service to him throughout his active life.

The story of his successes and disappointments, of his trials and failures, is told here in detail. We have something of the early life which trained him for the work which he was to do, and something of the later period which was passed in seclusion from the world and devotion to his work. He was so completely absorbed in this that he cared for little else really, and gave very little time to the society of others, preferring a life which left him free to think and work out the problems which presented themselves to his continually inquiring mind. He had few friends and fewer intimates; and while he valued these few and held them in high regard, yet he always subordinated everything to his work. He was fair and just to other engineers and was always willing to give them credit for good work done, but he fully understood and appreciated his own eminence, and could be, on occasion, very tenacious of his rights.

The picture given us is of a great man, but hardly a lovable one, even though it seems that those who knew him best were very strongly attached to him. It is a most interesting picture, nevertheless, and will well repay a careful reading.

## THE INTERSTATE COMMERCE COMMISSION.

*Fourth Annual Report of the Interstate Commerce Commission; December* 1, 1890. Washington; Government Printing Office.

The Interstate Commission in its present report covers a pretty extensive field. The statement of the work done during the year shows that the Commissioners are not permitted to waste much time, and also indicates some of the difficulties under which they labor. Some instances of the practical working of the law are given, to show its defects and the reasons why less has been accomplished than was expected.

A large part of the report is given up to the discussion of Rates in various forms, to through rates, rate cutting, and rate wars, and to the much-vexed "long and short haul" question. Ticket brokerage and commissions on business are also discussed at some length as a part of the same subject. Something is also said of the consolidation of roads, and of the control of lines by other companies. The Commission speaks now from experience, and has reached a very definite idea of what ought to be done in this direction—which, unfortunately, is very far removed from what is done.

The report also refers to what has been effected by conference with the Railroad Commissioners of the several States. The report as issued does not contain the statistical tables, to which frequent references are made.

In the light of experience, the Commission makes a number of recommendations for amendments to the law. These include a provision to compel roads to co operate in forming through lines; an amendment to make the present act clearer as to the penalties for violation of the law, and provision for bringing suit against corporations themselves; an amendment giving the Commission power to compel the attendance of witnesses; one to authorize free transportation for persons injured on the road and for those going to help them; amendments prohibiting the payment of commissions and the sale of tickets by brokers without authority; regulating mileage charges for the use of cars owned by private companies; giving the Commission authority to call for reports at intervals shorter than a year; and finally making the findings of the Commission final as to fact in a case, subject only to appeal to the United States Circuit Court.

All of these amendments are suggested by experience in the working of the law, and all of them seem to be desirable, if the law is to be executed. That the Interstate Commission has been of advantage both to the people and the railroads will now be admitted much more generally than would have been the case four years ago. That it is so is largely due to the wise selection of Commissioners made in the first place.

## THE WASHINGTON BRIDGE.

*The Washington Bridge over the Harlem River at One Hundred and Eighty-first Streeet, New York. A Description of its Construction; by William R. Hutton, Chief Engineer.* (New York; Leo Von Rosenberg.)

The deep and narrow valley of the Harlem River north of New York City was crossed a number of years ago by what was then one of the most notable bridges in the country, the stone arch bridge which carries the Croton Aqueduct across the river. The High Bridge, as it is called, was intended for the aqueduct alone, and is not available for ordinary traffic, and it has been necessary to erect near it another notable structure, which is known as the Washington Bridge, and which connects Tenth Avenue in New York with the section of the city known as Fordham Heights on the north side of the river. This bridge consists of two steel arches, one over the river and one over

the railroad tracks and lowlands on its eastern bank, and of masonry approaches which are in themselves arch bridges of considerable size. It is a structure well worth the handsome monogragh in which it is here described.

As we have heretofore remarked, the monograph is frequently a very valuable work to engineers, especially in the department of bridge construction. General principles can be given in the ordinary treatise, but it is only by description of particular structures that we can learn how the details are worked out and adjusted to fit varying circumstances.

The great feature in the book in question is the illustrations. Besides the general views and plans there are photographs of the masonry at different stages of its erection, photographs of the completed bridge, of the iron work, and finally a large number of drawings giving details of the masonry and of the superstructure in a very complete manner. The engravings are excellent, the drawings being clear and fine, and the execution good.

The reading matter includes some historical account of the construction of the bridge, a brief description and copies of the contract and specifications. It is to be repented that greater space was not given to the description, especially of the superstructure. It has been abbreviated so much that it is impossible to understand it properly without reading the specifications also, and many engineers, we think, would have found it much more convenient to have the information without recourse to the latter, which are not always easy reading. The drawings, it may be said, are so complete that it would hardly be possible to suggest any addition.

The mechanical execution of the book is excellent, and the publisher has brought it out in a style which leaves little to be desired, and corresponds to the importance of the book. It may be added that the large plates giving views of the different divisions originally submitted for the bridge form an excellent and very interesting addition.

## COMPOUND LOCOMOTIVES.

*Information Regarding Compound Locomotives Built by the Rhode Island Locomotive Works: By C. H. Batcheller, Chief Draftsman.*

This is a small volume of blue prints attached together, and giving an account of some experiments, or tests, made with a compound and a simple locomotive on The Brooklyn and Union Elevated Railroads, of Brooklyn, N. Y. Both engines were of the Forney type, with two pairs of connected driving-wheels, with a four-wheeled truck supporting the tank. The driving-wheels were 42 in. diameter, loaded with a little over 45,000 lbs. The cylinders of the simple engine were 11½ and 11 in. diameter respectively, with 16 in. stroke. The compound cylinders were 18 and 11 in. diameter, with 16 in. stroke. The engines were alike in every other respect, excepting the cylinders. The experiments were made for the Rhode Island Company, to guide them in designing compound locomotives.

This interesting volume reached us too late to reproduce any of the indicator and other diagrams appended to it, or even to analyze it as fully as it deserves. The compound engine was of the two-cylinder-type, the cylinders being connected by a copper receiver. A reducing valve is placed between the receiver and the boiler, so that the steam-pressure in the receiver is reduced in direct ratio of the piston areas, irrespective of the boiler pressure. This allows the compound to be used as a simple engine, and greatly increases its maximum power. In ordinary circumstances the engine starts from rest as a simple engine, with direct steam in both cylinders, which then have equal power. When the exhaust from the high-pressure cylinder produces the normal pressure in the receiver, the direct steam is automatically cut off from, and the receiver steam admitted into the low-pressure cylinder, and the engine is thus thrown into the compound system.

The road on which the experiments were made is five miles long, and in that distance has 16 passenger stations and two junction points, at which stops were required. The trains consisted of two light passenger cars during the middle of the day and late at night, and three or four cars during morning and evening hours. The running time is 24 minutes.

The experiments consisted of one day's service with each engine. They were started from the yard at East New York, at 6.15 A.M., and ran six miles, with a light four-car train, to Fulton Ferry, where they commenced service, making 22 trips (11 round trips) of five miles each, from Fulton Ferry to Ridgewood and return; then one trip of four empty cars to East New York, six miles, making a total train mileage of one hundred and twenty-two miles from 6.15 A.M. to 8 P.M. The coal used was soft anthracite. The steam-pressure in the simple engine was 140 lbs. and in the compound 155 lbs.

Under these conditions, the experiments showed that during the 13¾ hours that each of the engines were doing practically the same work, the simple engine burned 3,899 lbs. of coal and the compound 2,430 lbs., *or* 37.7 *per cent. less* than the simple engine.

This is a very extraordinary result and deserves careful consideration. The difference of steam-pressure in the two engines will be noted. This, of course, is a disparity in the conditions under which the experiments were made. If there is any advantage in using a high pressure in a simple engine, it should have the advantage thereof in a comparative test of this kind.

The report also shows that the boiler of the compound engine evaporated 8.25 lbs. of water per pound of coal, whereas that of the simple engine evaporated only 6.69 lbs. This is a difference of 23.3 per cent. In other words, as was noted in these pages with reference to the experiments with the Baldwin compound engine, the report shows that the boiler of the simple engine, which is said to be exactly like that of the compound, is nevertheless much less economical. In the language of Artemus Ward, "Why is this thus?" The reason for it is not explained in the report. If the simple engine could have had the advantage of the higher steam-pressure, and if the boiler had been as economical as that of the compound locomotive, it seems probable that the 37.7 per cent. of gain in fuel would be considerably reduced. What the report shows now is that a compound locomotive working at a pressure of 155 lbs., and an efficient boiler, burns less coal than a simple engine with 140 lbs. pressure and an inefficient boiler. No one doubts this, but what we all want to know is how much coal will be saved by a compound locomotive working under the same conditions and with boilers of equal efficiency. What, we think, may be objected to is saving coal in the boiler, and then attributing the advantage to the compound principle of working the engine. It is admitted that if this economy of the boiler is due to, and dependent upon, the compound feature, that it is properly an advantage which may be claimed for that principle, but if the same economy may be obtained with a boiler of a simple engine, then it is not one of the merits of compounding. Thus it may be said, that the more economical working of the boilers is due to the lighter exhaust of compound engines. If that is so, it is an easy matter to make the exhaust of simple engines as light as we choose. It is not asserted here that compound locomotives are not more economical than simple ones, but the extent of the economy is a subject of dispute the world over. Don't let us be misled by experiments which are not conclusive.

The report before us also contains a number of diagrams showing the "stress effects" on the crank-pin, showing that a compound locomotive brings to bear upon the moving parts a more continuous stress, or even while subjecting these parts to loads of less magnitude at the point of maximum stress, and that the effect of the applied power is also more regular in the com-

pound engine. This is a matter of more importance than is generally assigned to it. It is not quite clear, from the description, or the diagrams themselves, whether they take into account the effect of the inertia and momentum of the reciprocating parts, or whether they represent only the steam-pressure on the pistons. The construction of such diagrams is quite a complicated problem, and unless all the elements are taken into account, especially at high speeds, they are apt to be misleading. It is more important, however, that the rotative effect on the crank-pins should be uniform in starting than at considerable speeds, because as soon as the rotative effect exceeds the adhesive, the wheels will slip. Consequently, the maximum rotative effect which can be exerted is that which is equal to the adhesive. Now, it will be obvious that if such a maximum effect is exerted during the whole revolution of the wheels, that an engine will start and pull a heavier train than it would if it is exerted at only one or a few points during a revolution, and falls considerably below this between these points. For this reason it is desirable that the effect should be as nearly uniform as possible during the whole of the revolution of the wheels.

The report of these experiments has been very carefully prepared, and in that respect is a model of its kind, and is very creditable to its author, and to the Company which had the enterprise to have such a series of tests made.

## NEW PUBLICATIONS.

THE CATECHISM OF THE LOCOMOTIVE, *Second Edition, Revised and Enlarged:* by Matthias N. Forney, Mechanical Engineer. (The Railroad Gazette; New York.)

In view of what follows, a little explanation is perhaps needed here. The copyright of the original edition of "The Catechism of the Locomotive" was transferred to the present publishers of the *Railroad Gazette* some years ago, with my interest in that paper. The new edition of that book was therefore written under a contract with the present proprietors of the *Gazette*, for the publication of the new edition of the "Catechism." Consequently they are the publishers of the new edition of the book which has just been issued. With its character our readers are already familiar, as nearly the whole of the revised edition has been published in this JOURNAL. As the sub-title indicates, the new edition is revised and enlarged. The old book was $7\frac{1}{2} \times 4\frac{3}{4}$ inches in size; the new one is $8 \times 5\frac{3}{4}$. The old one had 609 pages, the new one has 709. The new edition is printed in type one size smaller than that used in the first, so that the amount of reading matter and the number of engravings is just about doubled. In the preface it is stated that, "since the first edition was written, in 1873, many changes and improvements have been made in the construction of locomotives, so that in preparing a second edition of the book the first one had to be thoroughly revised, and to a great extent rewritten, and a great deal of entirely new matter had to be added to bring it up to the present 'state of the art' of locomotive engineering."

Most of the illustrations are entirely new, and have been selected from the latest practice in this country. Additional chapters have been added on Force and Motion; Resolution of Motion and Forces; the Principles of the Lever; the Action of the Piston, Connecting-rod and Crank; Action of the Pistons, Cranks and Driving-wheels; the Westinghouse Air-Brake; the Care and Use of Air-Brakes; and the Eames Vacuum Driving-wheel Brake.

To make the construction of the Air-Brake clear, a large folded plate, printed in three colors, showing the principal parts of the brake on an engine, tender and car, has been added to the book. There are also five other folded plates showing a stationary engine, a diagram of the motion of a slide-valve, and a side-view, section and plan of an ordinary locomotive.

The presswork is only fairly good—some is positively bad—as, for example, the full-page engravings of locomotives, figs. 100–120. This is, however, largely due to the execrable quality of the paper which the parsimony of the publishers has led them to use, and which is disgraceful to them, an injustice to the purchasers of the book and a cause of mortification to its Author. As an example of the style in which publications are issued by the *Railroad Gazette*, it would seem likely to deter an Author in future from intrusting the issue of his productions to the company which is responsible for printing a respectable treatise on material like that used in the book which is the subject of this notice. M. N. F.

NINTH ANNUAL REPORT OF THE UNITED STATES GEOLOGICAL SURVEY TO THE SECRETARY OF THE INTERIOR, 1887–88: J. W. Powell, Director. (Washington; Government Printing Office.)

This report shows the progress made by the Survey during the year covered in topographic and geologic work, and contains also several special papers. One of these is on the Geology of Cape Ann; one on the Geology of Northwestern Colorado, including also the adjacent parts of Utah and Wyoming; one on the Formations by the Vegetation of Hot Springs, and the fourth on the Charleston Earthquake of 1886. The last named, which takes up 328 pages of the report, is accompanied by numerous illustrations, and is an exhaustive account of the phenomena observed in connection with the earthquake not only in and near Charleston, but throughout the country. It is a very interesting monograph.

The administrative reports give a fair idea of the amount of work accomplished by the Survey during the year, and the extent of country covered by its investigations. The topographic surveys covered an area of 52,062 square miles, while the geologic work was prosecuted on the Atlantic Coast, in the Northeast, in the Lake Superior District, in the Appalachian Mountain Region, in Colorado, in the Yellowstone Park, and on the Pacific Coast. The collection of mining and mineral statistics is also an important branch of the work, the results of which were published some time ago.

THE CIVIL ENGINEER'S POCKET BOOK: by John C. Trautwine, C.E. *Fifteenth Edition, Revised.* 866 pages, illustrated. (New York; John Wiley & Sons.)

Trautwine's Pocket Book has become so much of a standard and so indispensable to engineers since its first publication, in 1876, that it is not necessary to refer at any length here to its contents, or to attempt any criticism. It was revised in 1885, when the ninth edition was issued, and further changes have been made from time to time. In the present or fifteenth edition the principal features are a greatly enlarged article on Weirs, with suggestions for small measuring weirs, and a new article on Centrifugal Force. Minor changes have also been made in a number of other places in the way of correction or the addition of new information.

It is apparent that not much further addition can be made without departing from the form of a pocket book. It is already almost too large, and yet for the purpose for which it is intended it is difficult to see how anything could be omitted and still leave it the general hand-book of condensed information which it now is.

GEOLOGICAL SURVEY OF NEW JERSEY: FINAL REPORT. *Volume II, Part 2: Mineralogy, Botany, Zoology.* (Trenton, N. J.; State Printers.)

This is the third volume of the Final Report of the Geological Survey of New Jersey, a work which stands among the best and most thoroughly executed of any of its kind undertaken in this country. This part is taken up by a catalogue of the insects, animals, birds, fishes, and reptiles found in the State, with brief accounts of the various species and the localities where

they are to be looked for. Necessarily its interest is rather for the student than the general reader, and it would be somewhat presumptuous to attempt to criticise it without long and careful study. It is sufficient to say that the work has evidently been carefully and thoroughly done. That 822 pages should be required for the catalogue will surprise most people, for no one who is not a careful observer of such matters will appreciate the infinite variety of animal life to be found even in a small State, especially where the surface is of so varied a character as is presented by New Jersey.

It is interesting to note that the larger wild animals have almost disappeared from the State. The panther and wolf are known only by tradition; the bear and even the wild-cat are exceedingly rare, while deer, once abundant, are now only occasionally found. In a State so thickly settled as New Jersey there is little chance for any wild animals too large to conceal themselves readily.

The report bears the signature of the late Professor George H. Cook, who organized the Geological Survey and conducted it until his death with much ability. The present volume, however, has been completed and issued under the charge of Professor Cook's assistant and successor, Mr. Irving S. Upson.

PERMANENT FORTIFICATION FOR ENGLISH ENGINEERS: by Major J. F. Lewis, R.E. (323 pages, 43 plates). (Chatham, England; published for the Royal Engineers' Institute.)

"This book is written to save engineer officers trouble," is the opening sentence of the work, and it clearly explains the purpose for which it was prepared. It gives in a permanent form the practical information regarding the construction of batteries, magazines, and the mounting of guns, as practised in the English service, which an officer detailed upon such work might not otherwise have at hand.

Aside from the purely technical information contained in the book, something of interest to the general reader will be found in the fairly good idea it gives of English sea-coast defense. It is interesting to note the manner in which the English engineer has met the problem of preparing masonry fortifications to resist the attack of modern artillery. Wrought-iron shields for guns and fronts for batteries were applied some years ago to all their important works. It is now proposed to increase the thickness of metal as thus applied, and, in addition, to support it with heavy cast-iron blocks, after the pattern of Grüson armor. Protection of open batteries against vertical fire is to be secured by preparing them for a temporary cover of iron or timber, or both, in time of war.

BIBLIOTHECA POLYTECHNICA. *Directory of Technical Literature: A Classified Catalogue of all Books, Annuals, and Journals published in America, England, France and Germany.* Edited by Fritz von Szczepanski. (St. Petersburg; Fritz von Szczepanski, and New York; the International News Company, price, 75 cents.)

Such a catalogue as is proposed in the title of this book is no light undertaking, and its execution must have cost a large amount of labor. As to its completeness one can only judge after using the book some time; at present all that can be said is that it presents a very large number of titles, arranged carefully under appropriate heads. The titles of the various divisions are printed in English, French, and German; those of the books and journals in the language in which they are printed. The name of the publisher, the place of publication, and the price are appended.

It is to be regretted that the publisher did not adopt a somewhat larger type, even at the risk of making a more bulky book. The type used is somewhat trying to the eye. Fortunately the press-work is good and the pages clearly printed.

The book cannot fail to be useful to the student of technical literature, and may often save him a tedious search for works on some special subject.

THE NEW YORK AND BROOKLYN BRIDGE: *Plans of the Rapid Transit Cable Company for System and Terminals:* by A. Bryson, Jr., C.E. (New York; issued by the Rapid Transit Cable Company.)

Mr. Bryson's pamphlet is an addition to the already voluminous literature on the Brooklyn Bridge. It is devoted to a statement of the plan which he has worked out for arranging the terminals and operating the road in such a way as largely to increase its carrying capacity. It is fully illustrated by plans and drawings.

This plan, it is claimed, will not only improve the speed of trains and diminish the chances of accident, but it will shorten the time now required at the terminal stations and will do away with the use of locomotives for switching trains. The arrangement proposed consists of three circular loop tracks at the terminus, around which trains can be run without stopping or reversing their motion; some improvements in grip and details of working the cable are also included.

MECHANICS OF ENGINEERING AND OF MACHINERY; by Dr. Julius Weisbach. *Volume III, Part I, Section II: Mechanics of the Machinery of Transmission. Second Edition, Revised and Enlarged*, by Professor Gustav Herrmann. Translated by Professor J. F. Klein, D.E. (New York; John Wiley & Sons, 550 pages, price, $5.)

This volume is a small part of the new edition of Weisbach's great work, which is now being published in Germany, and on which the editor has been engaged for a number of years. The present section includes nine chapters: Ropes and Chains; Screws; Crank Trains; Cam Trains; Engaging and Disengaging Gear; Regulators. There is also an appendix on the Graphical Statics of Mechanisms.

The translation appears to be a very faithful one, and the engravings are the same as those used in the German edition.

The value of Dr. Weisbach's work is well known to those engineers who believe in his methods of treating the subject, and do not need criticism here. Where mathematical treatment and analysis are wanted his book is unquestionably very high authority, and no one will dispute its excellence.

The engravings are clear, but not by any means fine. They have had the advantage of good paper and careful press-work, for the mechanical execution of the volume is excellent.

THE MECHANICS' COMPLETE LIBRARY: *Modern Rules, Facts, Processes, etc., etc. For Engineers, Mechanics, Electricians, etc.* Compiled by Thomas F. Edison, A.M., and Charles J. Westinghouse. (Chicago; Laird & Lee.)

The contents of this book may be described by one word—hash; or perhaps this is not comprehensive enough, so that the Spanish term, *olla podrida*—which the dictionary says is "a dish consisting of a mixture of all kinds of meat, chopped fine and stewed with vegetables"—being more comprehensive, is better. In other words, it is a miscellaneous collection of selections, taken, apparently, from books, newspapers, or any other source, without order, classification, or any object, excepting to fill a certain number of pages, which will attract the attention of mechanics of limited education. The materials used in making hash are usually good, bad, and indifferent. The same is true of the contents of the book which is the subject of this notice. This much the reviewer feels bound to say, because he found some of his own productions formed part of the stew. Hash and the book are alike, too, in the fact that the one would be nutritious to a person physically hungry, and the other to those who never have had much intellectual food of this kind. The book, in fact, is hardly worthy of notice, but doubtless will serve a more or less good purpose to those whose mental tether is very short.

## TRADE CATALOGUES.

*Consolidated Safety Valve Company*, 111 Liberty Street, New York.

This is a neat pamphlet, with 57 pages 6¾ × 9¼ inches in size. It illustrates by engravings and descriptions all the varieties of "Pop" safety valves manufactured by this Company, with the methods of applying and using them. The illustrations, paper, and printing are all good.

*The Ashcroft Manufacturing Company*, 111 Liberty Street, New York.

This Company makes steam-gauges, gauge-cocks, water-gauges, pipe-tools, low water detectors, furnace doors, oil-testing machines, steam-engine indicators, etc., all of which are well illustrated and described in their catalogue before us. It is of the same size and "get up" as that of the Consolidated Valve Company.

*Pedrick & Ayer*, Philadelphia.

Like all the printed matter emanating from this establishment, their new catalogue is unsurpassed in what may be called its mechanical fabrication. Its paper, typography, engraving, border-lines, corner ornaments, are all in good taste. The book is bound in paper, has 66 pages 9¼ × 12¼ inches in size. Each page has a light gray tint over the surface occupied by the letterpress, which makes it very pleasant to the eye in reading. Our criticism is that the pages are too large, which makes the volume inconvenient to store and handle. This is noticeable, because all the engravings would go on a page half as large.

The illustrations and descriptions are of the machines made by this Company, consisting of Milling Machines, the methods and purposes for which these are used; Cylinder Boring and Facing Machines, Duplex Boring Machines, Portable Boring Machines, Universal Grinding Machines, Richard's Patent Open-Side Planing and Shaping Machines. These are all beautifully illustrated.

*Catalogue No. 1. Consolidated Car-Heating Company*, Albany, N. Y.

The consolidated Car-Heating Company announce in this catalogue that they have succeeded to the business and own the patents formerly the property of the Sewall Car-Heating Company, the McElroy Car-Heating Company; (Westinghouse) Standard Car-Heating and Ventilating Company; (Murdoch-Peerless) Automatic Car-Heating Company, and, in part, the (Leland) Universal Car-Heating Company, thus controlling some 100 patents covering the whole field of car-heating.

The catalogue before us contains descriptions of the various systems and the apparatus recommended by the Consolidated Company, with details of the various parts to facilitate ordering these separate parts. The book is 7 × 10 in., and contains 114 pages, with over 100 engravings. The catalogue is well printed on good paper, with excellent engravings. The criticism we feel disposed to make on it is that it contains too much of commendation and not enough of elucidation. A volume of this kind ought to be an elementary treatise on the subject to which it relates. To some extent the catalogue before us is a treatise, but if it explained the apparatus for car heating more fully, the volume would be more useful to many readers. As catalogues go, it is an excellent one.

*Schoen Manufacturing Company*, Pittsburgh, Pa.

This Company make various articles used in car construction out of pressed steel. Among these are stake pockets, center-plates, draw-bar attachments, corner bands, dead-blocks, bolster guide-bar columns and plates, brake-beams, etc. These are all described in their catalogue and illustrated with suitable engravings.

In the introduction to their catalogue, Messrs. Schoen say that, "By the use of their articles, the weight of the ordinary freight car will be decreased from 800 to 1,200 pounds, the cost of repairs reduced to a minimum, and the appearance of the car greatly improved, all without material increase in cost of construction."

This leads to the reflection of what might be accomplished if some master of design, with sufficient knowledge of car construction, could have an opportunity of designing a freight car with reference to a reduction of dead-weight. Various efforts, it is true, have been made in this direction in years past, but those who have undertaken it have generally been deficient in one or more of the following qualifications—first, theoretical knowledge of the strength and strains on materials, second, capacity for designing, and ingenuity in the adaptation of mechanical means to accomplish required ends, or third, practical and thorough knowledge of car construction. It seems certain that a person with these requisite qualifications might, by using Messrs. Schoen's and other improved devices, greatly reduce the weight of cars without any material increase in cost or decrease in strength or endurance.

*Thacher's Calculating Instrument.*

This is a small pamphlet issued by Messrs. Keuffel & Esser, of New York, and Mr. Edwin Thacher, of Louisville, Ky., the inventor of the instrument. The pamphlet contains a meager description of the instrument and a large number of testimonials with reference to its usefulness. The instrument, it is said, "consists of decimal scales arranged in parallel lines on the surface of a cylinder and on the inclined sides of triangular bars forming an open framework, within which the cylinder can be revolved or moved back and forth. By these movements any required portion of the scales on the cylinder are brought opposite any required portion of the scales on the bars, and the use of the instrument consists in the setting and reading of these scales, a simple operation readily acquired.

"The object of the instrument is to overcome the drudgery of calculation, and accomplish rapidly by mechanical means otherwise tedious arithmetical solutions. By the use of the instrument the mind is not only greatly relieved, but results are more reliable than when worked out in the usual way. There is less liability to error in the setting and reading of the scales than in ordinary arithmetical processes, but if mistakes should occur the work can be rapidly checked. After becoming once familiar with the instrument, results are obtained with great rapidity; this not only applies to ordinary calculations, but complicated formulas involving powers and roots are worked with equal facility. The useful applications of the instrument are as general as the rules of arithmetic. Examples in multiplication, division, proportions, powers or roots involving not more than three quantities, are solved by one operation, and any number of values of a single variable are found by one setting of the instrument."

## BOOKS RECEIVED.

*Determination of the Mean Density of the Earth by means of a Pendulum Principle: by J. Wilsing. Translated and Condensed by J. Howard Gore. From the Smithsonian Report for* 1888. Washington; Government Printing Office.

*First Lessons in Metal Working: by Professor Alfred G. Compton.* New York; John Wiley & Sons (price, $1.50).

*Valve-Gears: by Passed Assistant Engineer H. W. Spangler, U. S. N. Analysis by the Zeuner Diagram.* New York; John Wiley & Sons (176 pages, 106 illustrations; price, $2.50).

*Monographs of the United States Geological Survey. Volume I., Lake Bonneville; by Grove Karl Gilbert.* Washington; Government Printing Office.

*Annual Report of the Commissioner of Patents for the Year* 1889. Washington; Government Printing Office.

*Annual Report of the Chief of the Bureau of Statistics, Treasury Department, on the Foreign Commerce of the United States for the Year Ending June* 30, 1890: *S. G. Brock, Chief of Bureau.* Washington; Government Printing Office.

*De la Production et l'Emploi de la Vapeur Consideree comme Force Motrice: par MM. Lencauchez et L. Durant. Paris, France; G. Steinheil.* This is a reprint in pamphlet form of a paper prepared for the Société des Ingenieurs Civils at Paris.

*Les Avantages de la Haute Pression de la Vapeur dans les Machine Compounds: par M. A. Lencauchez.* Paris, France; published by the Author. Like the preceding, this is a reprint from the proceedings of the Société des Ingenieurs Civils.

*A Comparison of the Ball Automatic Cut-off Gear and the Stephenson Link Motion: by Harry P. Jones, M. E.* Portsmouth, N. H.; published for the Author. This is a reprint of a paper presented at the Indianapolis meeting of the American Association for the Advancement of Science, and subsequently published in the *Stevens Indicator.*

*Prospectus of the National Electric Light Association.* New York; issued by the Association.

*Bulletins of the United States Geological Survey;* Nos. 58, 59, 60, 61, 63, 64 *and* 66. Washington, Government Printing Office.

*The Metric System: Detailed Information as to Laws, Practice, etc.* New York; the American Metrological Society.

*Columbia Cycle Calendar for* 1891. Boston; the Pope Manufacturing Company. This is an exceedingly convenient calendar for the desk.

*How to Bore a True Hole: Waterman's Book about Nicholson's Horizontal Borer.* Providence, R. I.; the Nicholson & Waterman Manufacturing Company.

*Municipal Lighting: by M. J. Francisco. With Appendix: Correspondence with John P. Barrett, of Chicago.* New York; published by order of the National Electric Light Association.

*Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department. Relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending June* 30, 1890: *S. G. Brock, Chief of Bureau.* Washington; Government Printing Office.

*Transactions of the Canadian Society of Civil Engineers: Volume III, January—December,* 1889. Montreal; printed for the Society.

## ABOUT BOOKS AND PERIODICALS.

AMONG the articles in BELFORD'S MAGAZINE for December is one by E. F. Boyd on the Power of the United States, which contains some predictions as to the future growth of the country in population. An article on the *Merrimac* and the *Monitor,* by J. L. Le Faucheur, gives the often-told story of the first fight of iron-clads from a Confederate point of view. Military readers will be interested in the two articles by Generals Longstreet and Trumbull sharply criticising Lord Wolseley's work as a military critic. This magazine has its own opinions on current topics, and does not hesitate to express them in a very emphatic and readable way.

The large number of readers who wish to know something of foreign magazine literature, but have not time or opportunity to read the foreign periodicals, should be grateful to the ECLECTIC MAGAZINE for the judicious selection which it presents each month. A striking article in the December number is an appreciative review, from *Blackwood's Magazine,* of Captain Mahan's "Influence of Sea Power on History"—a remarkable book, by an American naval officer of high standing.

The December number of SCRIBNER'S MAGAZINE is a Christmas number, and is given up chiefly to holiday literature of the lighter kind. It contains the first of Sir Edwin Arnold's papers on Japan, which is a general description of the country, and is apparently a preliminary or introductory paper for the series which will follow it.

With the December number the ARENA begins its second year, and it may be said that in its first this magazine has fairly earned success. As a field for the full and free discussion of social and economic questions of current interest its name is well chosen, and it has made for itself a recognized position which no other magazine holds or has held heretofore. That this is no easy thing for a new periodical to do hardly needs to be said, but in this case the place has been secured by meriting it.

Like some of the other magazines, HARPER'S for December is a holiday number, and is chiefly given over to lighter literature. Mr. Charles Dudley Warner's sketches of Southern California are continued in this number, picturing a very attractive country, with a solid basis for continued growth in its natural advantages and resources.

In the POPULAR SCIENCE MONTHLY for December an illustrated article on Early Steps in Iron Making, by W. F. Durfee, is the first of a series of articles on the Development of American Industries since Columbus. These will include all the prominent branches of manufacture, and will be written by experts in the several branches. Mr. Barr Ferree writes in this number on Architecture and its Environment. A striking article on the Identity of Light and Electricity is by Professor Henri Hertz.

The reader who is interested in outdoor sports of all kinds will find OUTING for December an excellent winter number. As usual with this magazine also, no inconsiderable amount of information on travel and geography can be found in its columns for the month.

A number largely historical is presented by the OVERLAND MONTHLY for December. General John Bidwell contributes some interesting reminiscences of the Conquest of California, and Mr. Willard B. Farwell concludes his paper on the much disputed question of Fremont's Place in California History. Eastern Oregon finds its place in a short but comprehensive article. Those who like to read of the less known parts of the earth will find much information in a paper on Borneo and Labuan, by a writer whose name is not given.

M. Mallet, the well-known French engineer, has issued in pamphlet form a paper prepared by him for the Société des Ingenieurs Civils at Paris on the Development of the Application of the Compound System to Locomotives. It is an interesting study on the subject, and is illustrated by a number of diagrams.

The latest quarterly number of the JOURNAL of the American Society of Naval Engineers contains articles on the Graphic Method for Determining and Counterbalancing the Centrifugal Action of the Connecting-Rod, by Passed Assistant Engineer A. B. Canaga; the Ericsson Compound Engine and Belleville Boiler, by Chief Engineer B. F. Isherwood; New Forms of Evaporators, by Passed Assistant Engineer G. W. Baird; Analysis of Engine Trials, by Assistant Engineer W. H. Allderdice; Trial of the *Philadelphia,* by Assistant Engineer W. H. Chambers; Trial of the *San Francisco,* by Passed Assistant Engineer E. T. Warburton. There are also a number of interesting short notes on current topics, and a continuation of the discussion on Tubulous Boilers.

## THE NEW GEODETIC SURVEY OF FRANCE.

(Condensed from *Le Genie Civil.*)

A GENERAL geodetic survey of France was projected some time ago, and was begun under the direction of M. Bourdaloue in 1857, but was abandoned in 1864, after the base-lines only were completed.

The new general survey was begun in 1884 and is now in progress; it comprises:

1. A new system of base-lines, in all about 7,500 miles long. These generally follow the main lines of railroad, the easy grades of which permit very accurate leveling and measurement.

2. Subordinate detail lines, including about 500,000 miles in all.

3. A system of contour lines extending over all French territory.

The new base-lines will also be made to serve to connect the geodetic survey of France with those of neighboring countries, and to compare the mean levels of the Mediterranean, the Atlantic and the English Channel.

The cost is estimated at about $4,000,000. The work is under the direction of M. Lallemand, who has very fully described its progress and methods in a work—Traite de Nivellement de Haute Precision—recently published.

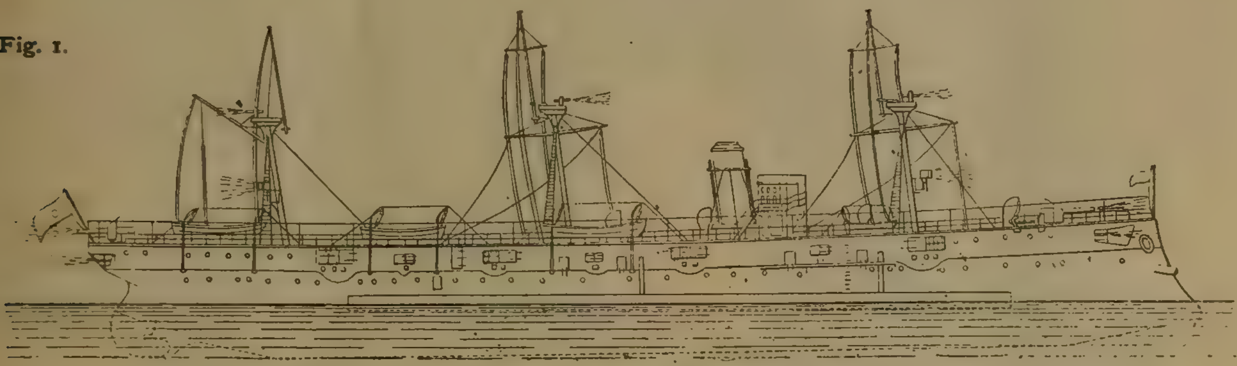
The base-lines consist of closed polygons, averaging about 380 miles in perimeter. Fixed bench-marks are placed 500 to 1,000 yards apart. Each section between two bench-marks is leveled in both directions, and one day's work is confined to each section. All reductions and calculations are made at a central office. The bench-marks are of oxidised iron or bronze, and built into the walls of solid buildings. They enclose a tablet describing their position in the survey and the level.

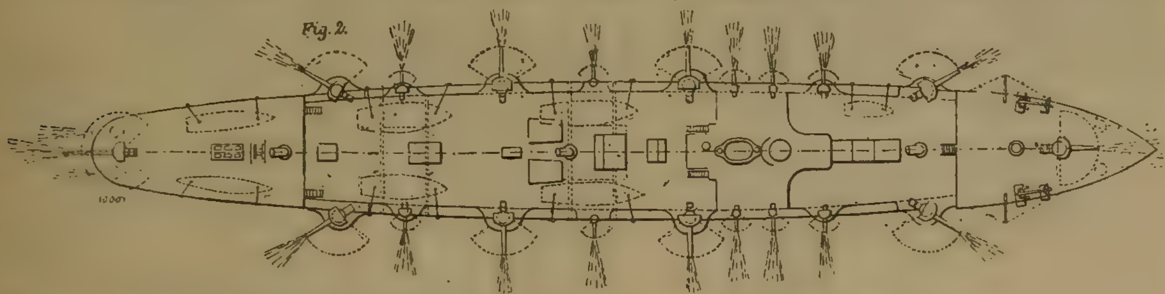
The level used is carried on a spherical bearing, which permits the telescope to be rapidly placed approximately level without moving the legs. By means of reflecting prisms the two ends of the bubble-glass are visible to an observer standing at the eye-piece of the telescope, so that he can verify the accuracy of his adjustment at any moment without leaving his post.

The staff used is the compensating staff of Colonel Goulier, which contains a double metallic rule of iron and brass, by which the variation in length of the graduations on the wooden staff can at any moment be observed. This variation is observed three times a day by the leveler, and amounts to some thousandths per cent., having a daily and also a yearly period, and varying from one staff to another. The divisions are in centimeters, 5 millimeters and 2 millimeters. These divisions are not accurately equal, a systematically erroneous division being preferred, in which the law of error is only known at the central office, as thus it becomes more difficult for the operators to attempt to correct any observations the results of which do not sufficiently agree.

About two-thirds of the base-lines are now leveled, and this first part of the work will be finished before three years. The probable error amounts, on the average, to less than 0.9 millimeter for a distance of 1 kilometer (about 0.57 in. per mile), while in the operations of Bourdaloue it amounted to from 2 to 3 millimeters per kilometer (0.13 to 0.19 in. per mile). The probable error from Marseilles to Lille does not exceed 2 in. The datum level is the mean sea-level at Marseilles, and a new tidal gauge has been established there, in order to determine the datum anew with great accuracy.

Fig. 1.






THE NEW CRUISER "CHIYODA," FOR THE JAPANESE NAVY.

## A JAPANESE CRUISER.

THE accompanying illustrations, which are from London *Engineering*, show the new cruiser *Chiyoda*, built by the firm of J. & G. Thompson, Glasgow, Scotland, for the Japanese Government. The *Chiyoda* is intended for a fast cruiser carrying a heavy battery of rapid-fire guns, and was designed in the Japanese Navy Department, although some changes have been made in accordance with the advice of the contractors. It is expected that her speed will reach 19 knots an hour under forced draft.

The principal dimensions are: Length, 310 ft.; breadth, 42 ft.; depth, 23 ft. 8 in.; mean draft, 14 ft.; displacement, 2,450 tons.

In the illustrations, fig. 1 is a profile view; fig. 2 a deck plan; fig. 3 a partial cross section, showing the means adopted for protection. The large engravings give two views of the engines.

As shown in figs. 1 and 3 the water-line for two-thirds of its length will be protected by a belt of 4-in. steel plate bolted on the outside of the shell, and extending for about two-thirds the length of the ship. The machinery and magazines are protected by a steel deck extending the whole length of the ship, and having an average thickness of 1 in. This deck is made in two layers, the lower of ordinary steel and the upper of chrome steel. The space between the protective deck and the ordinary deck will be

filled with coal, as shown in fig. 3, and the arrangement of the coal bunkers on the sides of the ship will also serve for additional protection. A belt of celluloid is placed back of the armor-belt and also back of the coal bunkers and over the engines, as shown in fig. 3.

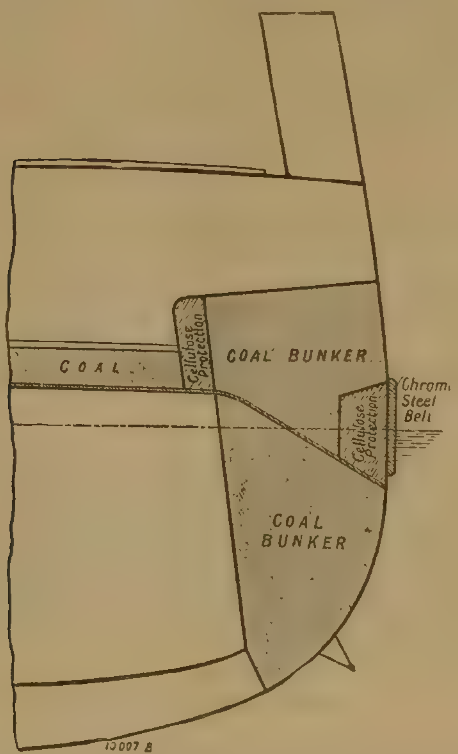
The ship is lighted throughout by electricity, and has powerful search-lights, one forward and one aft. She carries three masts, each having a military top containing a Gatling gun. The vessel has a double bottom, and is divided into numerous compartments.

In order to provide for good manœuvring power, a patent balanced rudder has been fitted, on the principle already adopted in the *Reina Regente* and other war vessels.

The armament consists of ten 4.7-in. Armstrong rapid-fire guns mounted, as shown in fig. 2, on the main deck. The secondary battery includes fourteen 47-mm. Hotchkiss guns and three Gatling guns. There are also three torpedo tubes, one at the bow and one on each broadside.

The engines, which are shown in the large engraving, are vertical, inverted triple-expansion engines, one to each screw, and are arranged so as to give a strong structure for

Fig. 3




the minimum of weight, and at the same time to make all the working parts easily accessible. The cylinders are supported by steel columns bolted to a cast steel bed plate. The cylinders are 26½ in., 39 in. and 57 in. in diameter, with 27 in. stroke. They are all fitted with piston-valves, worked as shown in the engraving from eccentrics placed on the main shaft, driving links. The air-pumps are worked from the low-pressure crosshead. When running at full speed these engines will make 230 revolutions per minute.

Steam is supplied by six locomotive boilers placed in two separate water-tight compartments forward of the engines. The boilers are of steel, and are 7 ft. in diameter and 18 ft. long, each having two fire-boxes. Forced draft is applied on the closed stokehold system. There are four fans 60 in. in diameter and intended to make 250 revolutions per minute. Each fan is driven by a direct-acting single cylinder engine.

The coal capacity is about 700 tons. At a speed of 10 knots per hour the cruising range is estimated at 8,500 knots.

The *Chiyoda* was launched in June last, and is now being completed for delivery to the Japanese Government.

## THE BRAYE TUNNEL.

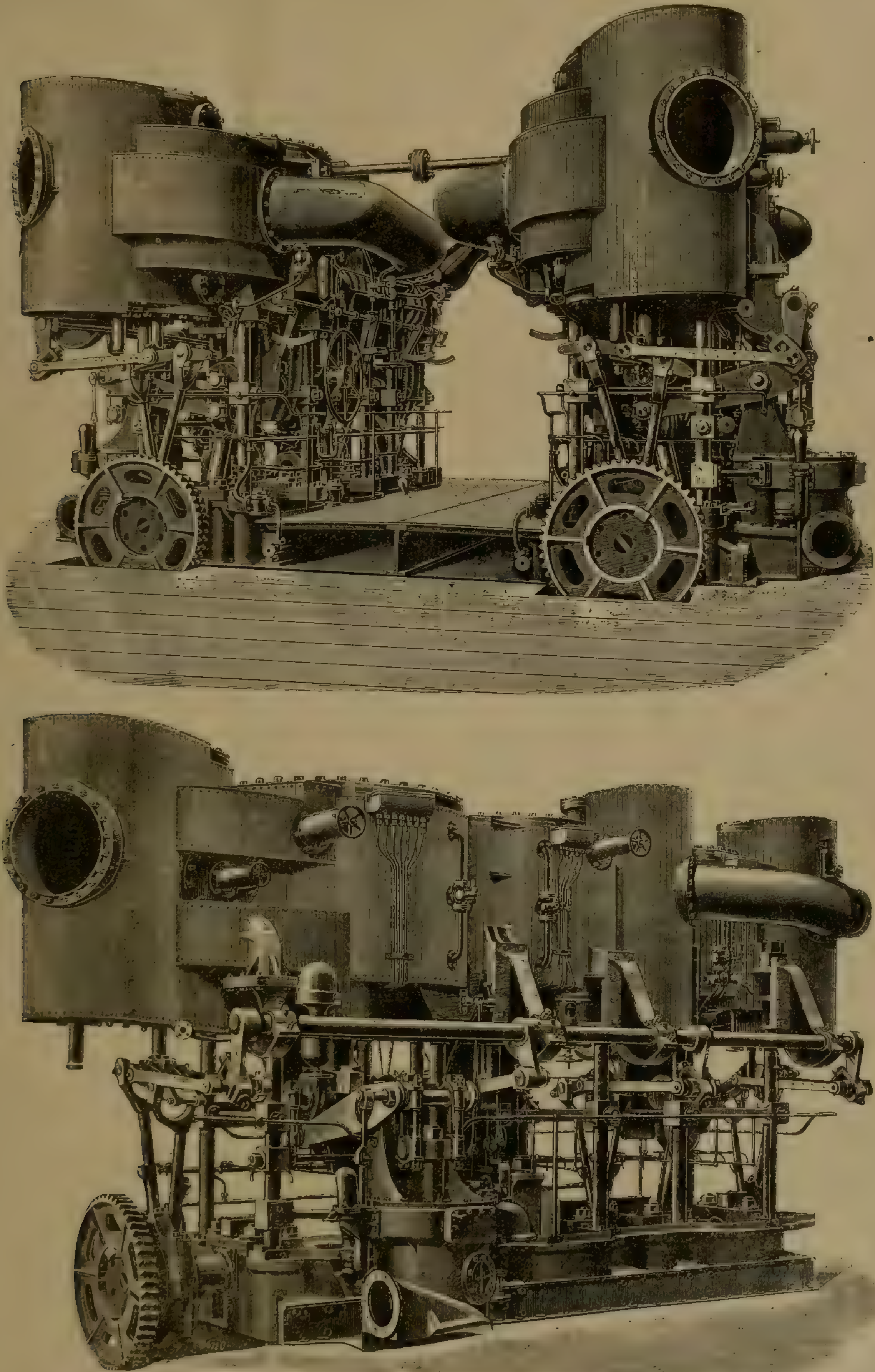
(Papers of the Institution of Civil Engineers.)

THE summit dividing the basins of the Oise and Aisne, in France, on the navigable canal in course of construction between these rivers, is passed by a tunnel 7,740 ft. long, at a depth of 400 ft. below the crest of a ridge, which is made up of alternations of sands and clays capped by the *Calcaire Grossier*, the whole being of eocene tertiary age. The stratification, which is regular in the higher parts, is subjected to a disturbance at the base, so that the tunnel, which should be entirely in the lower sand, *Sable de Bracheux*, with about 40 ft. of cover, consisting of clays and lignites, between it and the overlying Soissons sands, passes through a short fold of these clays, which at 900 ft. from the mouth on the side of the Oise brings the crown of the roof into contact with the upper sands, causing a great flow of sand and liquid clay into the heading, so that it became necessary to carry out this part of the work by compressed air.

The plant required was erected in 1883; it comprised seven portable steam-engines, altogether of 220 H.P., driving eight compressors, capable of supplying 180,000 cubic feet of air, at double the atmospheric pressure, to the working chamber in 24 hours. A series of reservoirs, of about 3,000 cu. ft. capacity, were also provided for air at 4 to 6 atmospheres absolute pressure, which was used for the removal of the excavated material.

The working chamber at the face of the tunnel was formed by a wall of masonry, perforated by air-locks, giving admission and exit to and from the chamber. At first this wall, 11 ft. thick, was placed about 400 ft. from the mouth of the tunnel, but subsequently a second one, improved in many particulars, was placed at 614 ft., and the first was removed. This dam, built of concrete between retaining walls of dressed stone, was 22 ft. thick in the center, and 26½ ft. at the bottom, where the two air-locks were placed; a passage for a third lock was also provided, but was walled up. In the upper part of the dam two other passages were left for the tubes serving for the removal of the débris, and these were similarly walled up when the tubes were erected.

The air-locks were of the section of ordinary mining-galleries, 26½ ft. long, 5 ft. 5 in. broad, and 7 ft. 3 in. high, or sufficiently large to allow the passage of mine-wagons. They were provided with a sheet-iron lining, built up in rings, bolted together with india-rubber washers, and air-tight doors closing against seats faced with india-rubber, opening inward—that is, from the outer air to the lock, and from the latter into the working chamber. At first the doors were closed by screws, but these were inconvenient on account of the slowness in manipulation, and rack and pinion movements, governed by levers, were substituted. The pressure of the air released the lever, which was then lowered shortly after use, so that the door was only kept closed by the difference of pressure on the two sides and in the levels. They opened of themselves as soon as the two sides were in equilibrium. The outer door had only a single lever worked from within the lock, while the inner one had one on each side, so that it could be worked either from within or without the chamber. The low-pressure air was introduced by four pipes placed close to one of the walls, and that at high-pressure, for the removal of spoil and water, by a fifth near the bottom. Two 16½-in. pipes were passed through the upper arches, and two of 13¾ in. through the bottom of the wall, both series being provided with stop-valves at the ends. The larger pipes inclined outward, and were turned up to a vertical position within the chamber. When required for use the inside valve was opened, the tube filled with spoil and closed again. At a given signal the outer valve was opened, at the same time as that connecting the tube with the high-pressure main containing air of at least four atmospheres pressure, which cleared out the contents in a few seconds. The outer valve was then closed and the filling repeated as before. In the same way the water accumulating in the bottom of the chamber was driven out by connecting the lower tubes with the high-pressure air service. The working chamber was lighted by Edison glow lamps and a Gramme dynamo



TRIPLE EXPANSION ENGINES FOR JAPANESE CRUISER "CHIYODA."

worked by a 15 H.P. engine, and telephonic communication was established between the face and the office. The preparations having been completed, work was begun early in 1884, and from the first great difficulty was experienced in keeping the chamber air-tight, the compressed air finding its way out not only through the penetrable strata above, but also along the extrados of the roof and the timber struts required for the support of the ground. It was only after building 20-in. buttress-rings on either side of the dam that the pressure on the chamber could be brought up to 1.8 and 2 atmospheres (absolute), under which condition the roof was completed to about 660 ft. from the mouth, at the rate of 39 to 48 ft. per month, when the work was stopped by an accident in August, 1884. This was caused by the compressed air getting into the overlying pyritic lignite-bearing strata, and after driving out the water oxidizing the pyrites, whereby sufficient heat was developed to fire the lignite, and the products of combustion penetrating to the chamber caused the death of 17 men by suffocation. In order to render the working accessible after this accident six bore holes were put down from the surface to the seat of most active combustion to give free issue for the gases, which were driven out of the chamber by projecting highly compressed air into it, the mean pressure being kept at 1.6 atmospheres. On October 4 the chamber was accessible, and after the ground had been properly shored up, the pressure was removed, and the surface water being no longer kept back, penetrated to the seat of the fire and extinguished it; but the heat developed was sufficient to keep the temperature of the water trickling through the roof at 90° for six months. After the accident the first dam was removed, and the second at 614 ft. was erected, as previously described. Provision was also made for the active ventilation of the part of the tunnel open to the air, by sinking a shaft a little on one side, and connecting it with the crown of the arch by a short inclined drift at 358 ft. from the mouth. This shaft was closed at the top and provided with a Pelzer fan, 6 ft. in diameter, with a minimum exhausting capacity of 500 cu. ft. per second, a return air-way 6 ft. wide, being formed on the left side of the tunnel, by a brattice wall of masonry carried from the bottom of the pit to a point 13 ft. behind the new dam. Working with compressed air was renewed in March, 1885, but the difficulty of keeping the chamber tight was found to be as great as before. It was therefore resolved to wall up the face at 820 ft., and increase the dam by leaving a breadth of 60 or 70 ft. of ground unbroken, with the exception of three small galleries, two at the bottom and one at the crown of the arch, which were carefully lined with masonry. The upper one proved a failure on account of the large leakage at its mouth, and was blocked up by a 39-in. wall, after a length of 85 ft. had been driven; but the lower ones being driven in compact clay, succeeded better, and remained perfectly tight when 33 ft. had been lined on the left side and 79 ft. on the right. A pressure of 2.3 to 2.4 atmospheres was then kept up in the workings by the use of two-thirds of the motive power during the remainder of the time that it was required. The lower galleries were carried forward to some distance beyond the dangerous ground at 983 ft. from the mouth, their outer walls being constructed of the full thickness of the lower part of the finished side walls of which they formed part up to a height of 8 ft. 8 in., a further height of 8 ft. 4 in. to the opening of the arch being put in by galleries driven above the lower ones in lengths of about 70 ft. at a time. This work proceeded at the rate of 5 ft. per day during the working period, which was, however, interrupted on four different occasions, owing to fresh fires in the lignite, causing the abandonment of the work for a time.

When the walls were finished to 1,302 ft., a rise was put at 1,286 ft., and a length of 13 ft. of the arch was completed. From this point the work was carried on in both directions, but principally backward, at the rate of about 40 ft. per month of actual work. The crown of the arch, although partly in running sand, was kept sufficiently tight by timbering and closely driven packing laths, when care was taken to insert the latter singly, and to drive each one perfectly tight before placing the next. The sand was rendered sufficiently coherent by the compressed air not to run as long as only a small surface was exposed at a time. The arch was joined up to the point where it was first stopped, in September, 1887, and the excavation of the full section and construction of the invert, which was done in face, was resumed after the "decompression" of the chamber, on September 25, and completed to 1,476 ft. at the end of October, 1888. The cost of this part of the work was about $400 per foot.

The full section of the finished tunnel inside is as follows: Height, 28 ft.; width at bottom, 24 ft. 7 in.; width at spring of arch, 26 ft. 3 in. The extension toward the Aisne Valley was carried on from shafts sunk in the manner described below.

The middle section of the Braye Tunnel is reached by two shafts known as Nos. 2 and 3, respectively 301 ft. and 378 ft. deep, and distant 3,543 ft. and 5,166 ft. respectively from the mouth on the Aisne side, which necessitated passing through from 40 to 70 ft. of the Soissons sands below the water-level. The method adopted for sinking was similar to that formerly applied in making the Rilly la Montagne tunnel on the Reims & Epernay Railroad—namely, the use of cast-iron tubbing through the water-bearing bed, which was afterward secured by underpinning with oak cribs, the ground being kept dry during the erection of the latter by the use of compressed air.

The shafts, rectangular in section, 5 ft. 3 in. wide, and divided into three compartments, of the respective lengths of 5 ft. 7 in., 5 ft. and 3 ft. 6 in., were put down to about 30 ft. below the water-level by the ordinary method of timber frames, 40 in. apart, and close boarded sides, when further progress by this means became impossible, and cast-iron tubbing was substituted. A separate tubbing was used for each compartment. The rings, 1.2 in. thick and 39.4 in. high, ribbed and flanged inside, are united by bolts through the flanges, the joint being kept tight by an india-rubber ring filling seats turned into the adjacent flanges. The bottom ring was provided with a cutting edge. The erection of the tubbing-column was effected at the bottom of the shaft in a depth of 25 to 30 ft. of water, and when completed pumping was stopped, and the water allowed to rise to the natural level, in order to prevent irregular movement of the ground during the working, which, by causing dangerous hollows, was likely to endanger the timbering of the upper part of the shaft. The sand was at first excavated by a bucket-dredger, then shell augers were used, but finally divers filling the sand directly into tubs were found to be most expeditious. The diver removed the sand at the bottom of the compartment, but without uncovering the cutting edge of the tubbing; the column was then forced down by hydraulic jacks of 20 tons power, until a depth of 20 to 40 in. was attained, when the sand was again cleared out, and so on, the work being done alternately in the different compartments. It was hoped that a tight joint would have been obtained when the cutting-ring had penetrated the clay below, but, owing to the small breadth of the ribs dividing the different compartments, they gave way, and allowed the sand to penetrate from above. It therefore became necessary to have recourse to compressed air in order to render the junction of the tubbing with the ordinary timbering impermeable. For this purpose airlocks were established at the mouth of each compartment; one of these, allowing the passage of timber, was 16½ ft. high, and the others 7½ ft. each. The air-compressor was driven by a 15-H.P. portable engine, and maintained a pressure in the bottom varying from 2.35 to 2.8 atmospheres.

The joint was formed of six oak rings, from 9½ to 10½ in. square, and from 4 ft. 4 in. to 6 ft. in inside diameter, built into a pile 5 ft. high. The broadest rings at the bottom resting on a ledge cut in the impermeable strata, and the narrowest one bears against the bottom of the tubbing, the cutting edge of the shoe resting in a groove in the upper surface containing an india-rubber washer. The seat for these rings was made by excavating a bell-mouthed chamber, which was filled up with concrete carefully rammed after the rings had been placed in position, and packed with moss and wedged in a similar manner to that employed in coal-pit sinking. The order of placing the rings was somewhat peculiar. The top ring, No. 1, under the tubbing, was first placed provisionally; then the broader ones, Nos. 6 to 3, were built up, and the hollow behind con-

creted, and finally No. 2 was driven in between No. 3 and No. 1. The joint between the tubbing and No. 1 ring was further secured by a sheet-iron ring backed by cement. Afterward the sinking was resumed at the ordinary pressure, and secured by close cribs of oak for a depth of 6 ft., below which ordinary frames 40 in. apart are used as in the upper part.

The cost of these appliances to the two shafts was $55,080 for a depth of 161 ft. 9 in., or about $340 per foot.

## TESTS OF SOME ARKANSAS SYENITES.

By J. Francis Williams, C.E., Ph.D.

(Published by permission of the director of the Geological Survey of Arkansas.)

The following tests were made for the Geological Survey of Arkansas, with a view of determining the fitness for building stone, as far as strength and absorptiveness is concerned, of the syenites found in the State.

The syenites of Arkansas are grouped into three regions, and are known as the Fourche Mountain or Little Rock, the Saline County and the Magnet Cove syenites. The first of these groups forms the Fourche Mountain, a few miles south of Little Rock, and contains the so-called "Blue Granite," which is an elæolitic augite hornblend syenite, and some "Gray Granite," which is a light gray, coarse-grained, elæolite syenite. The "Blue Granite" has already become a very important building stone, and many edifices, both in Little Rock and elsewhere, have been constructed of it. It is also much used in making the Belgian blocks so extensively employed in paving. The "Gray Granite" has been worked to some extent for trimmings and ornamental stone.

The Saline County region contains almost exclusively elæolite syenite of a reddish or grayish color, but it has as yet found only a very limited market, on account of its distance from the railroad, which is, however, only about four miles.

The rock of the third region is for the most part an elæolite augite syenite, and has been quarried at two points. It was formerly used in making millstones, and has lately found some application in building railroad culverts and in the foundations of houses.

The tests, of which the results are given below, were made in the mechanical laboratory of the Rensselaer Polytechnic Institute, at Troy, N. Y., on a 50,000-llb. Tinius Olsen testing machine. Thes pecimens were cubical in form, and were cushioned with pieces of book-binders' board* about $\frac{3}{16}$ in. in thickness. The cubes were cut by Peter Grant, of Troy, N. Y., from larger blocks taken directly from the quarries, and were finished down to sand-rubbed surfaces. These specimens were carefully measured with a micrometer measuring apparatus. The area over which the pressure was distributed was calculated, and the weight found necessary to crush each block was reduced to pounds per square inch. In the fifth column of the table given herewith are placed the pressures per square inch, which were found by the experiments recalculated by means of Gillmore's* cubic parabola formula to corresponding pressures per square inch in 2-in. cubes. The rock showed no bedding nor false stratification in any direction, so that those faces which were most perfect and most nearly parallel were chosen as those to which to apply the pressure. The specimens broke suddenly with an explosive force, and in some cases the small pieces tore the heavy binders' board completely to pieces.

The specific gravity and ratio of absorption were determined by following the methods suggested by Gillmore† and Merrill‡ respectively, as follows: Small, irregular pieces of stone weighing from one to three ounces were smoothed until they presented no sharp corners nor rough edges; these were next accurately weighed ($A$) and then immersed in water and allowed to soak for 24 hours. After the expiration of that length of time they were weighed suspended § in water at 60° Fahrenheit ($B$), and then weighed again after having been quickly dried externally ($C$). When the various weighings are represented by letters, as indicated above, the formulæ for the ratio of absorption and specific gravity become as follows:

| No. | Description of Specimen. | County where Found. | Area of Surface in square ins. | Actual Crushing Load. | Pressure per square inch. | Reduced to correspond to pressure per square inch in 2-in. cubes. | Ratio of Absorption—1 to :— | Specific Gravity at 60° F. |
|---|---|---|---|---|---|---|---|---|
| 1 | Light colored elæolite syenite, slightly decomposed...... | Saline. | 2.34 | 48,coo | 20,500 | 22,350 | 761 | 2.62 |
| 2 | "Gray Granite," a very light-colored elæolite syenite... | Pulaski. | 2.25 | 33,750 | 14,000 | 16,000 | 83 | 2 45 |
| 3 | Brownish elæolite porphyry, occurs in narrow dike...... | " | 1.42 | 30,000 | 21,000 | 24,980 | 161 | 2.52 |
| 4 | "Light-blue Granite" (syenite)........................ | " | 1.64 | 47,000 | 28,700 | 33,280 | .... | ... |
| 5 | " " " (somewhat darker).... .. | " | 1.07 | 22.800 | 21,500 | 26,820 | .... | .... |
| 6 | " " " (still darker)... ...... ... | " | 1.57 | 35,950 | 22,900 | 26,745 | 1,673 | 2.64 |
| 7 | "Medium Blue Granite" (syenite).................. | " | 1.50 | 43,500 | 29,000 | 34,150 | .... | .... |
| 8 | "Dark Blue Granite" (syenite porphyry)................ | " | 1.57 | 43,800 | 27,900 | 32,630 | 4,530 | 2.69 |
| .. | Mean of last five specimens. Average for "BlueGranite." | " | .... | .... | 26,000 | 30,740 | .... | .... |

$$\text{Ratio of absorption} = 1 \text{ to } \left(\frac{A}{C - A}\right).$$

$$\text{Specific gravity} = \frac{A}{A - (B - [C - A])} = \frac{A}{C - B}.$$

The last five specimens represent those rocks which are usually employed in construction, and were taken from the more important quarries on Fourche Mountain; but as there is very little to choose between them, and as it is not at all certain that the specimens were all from equally fresh material, and were subjected to the same amount of jar and strain in dressing, it would be of no real value to give the names of the quarries from which the individual specimens came, and it might lead to discriminations where such are not warranted.

The average pressure per square inch which the blue granite (syenite) stood is remarkably high, and shows that the stone is well fitted for building purposes, and especially for paving blocks. As there is little or no pyrite and magnetite present, it is probable that the rock will long retain its pleasing color, and will form a durable and desirable building stone.

* For a description of the use of these see "Tests of Rutland and Washington County Slates," by J. Francis Williams, *Van Nostrand's Engineering Magazine*, Vol. CLXXXVIII, New York, 1884, p. 101.

* Q. A. Gillmore: Report on the Compressive Strength, etc., of the building stones of the United States in most general use. Appendix II of the Annual Report of the Chief of Engineers for 1875. Washington, 1875, pp 19. and 20.

† Q. A. Gillmore, l.c., p. 7.

‡ Annual Report of the Board of Regents of the Smithsonian Institution, etc., for the year ending June 30, 1886. Washington, 1889. The Collection of Building and Ornamental Stones in the U. S. National Museum: A Handbook and Catalogue, by George P. Merrill. Part IV, p. 490, foot-note.

§ The specimens were suspended by a fine platinum wire, whose weight when immersed in water to the same extent as when suspending the stone was accurately determined and subtracted from the total weight of the submerged mass.

## THE USE OF WOOD IN RAILROAD STRUCTURES.

BY CHARLES DAVIS JAMESON, C.E.



(*Continued from page* 554, *Volume LXIV.*)

### CHAPTER XXX.

HOWE TRUSS BRIDGES.

THE designs for Howe Truss bridges of 100 ft. and 120 ft. span are given in the accompanying illustrations; both are through spans. Plate 125 shows the 100-ft. span and Plate 127 the 120-ft. span, the details being given in Plates

No. 51. BILL OF MATERIAL FOR HOWE TRUSS BRIDGE. THROUGH SPAN 100 FT. PLATE 125.

*Timber.*

| No. of Pieces. | Description. | Size. | Length. | Feet B. M. | Kind of Wood. |
|---|---|---|---|---|---|
| 20 | Top Chord...... | 7 in. × 12 in. | 20 ft. 0⅛ in. | 2,820 | Yellow Pine. |
| 4 | " " ...... | 7 in. × 12 in. | 37 ft. 0⅞ in. | 1,040 | " " |
| 4 | " " ...... | 7 in. × 12 in. | 17 ft. 0¾ in. | 480 | " " |
| 8 | " " ...... | 7 in. × 12 in. | 7 ft. 0⅛ in. | 400 | " " |
| 4 | Bottom Chord.. | 7 in. × 14 in. | 39 ft. 0 in. | 1,274 | " " |
| 4 | " " .. | 7 in. × 14 in. | 29 ft. 0 in. | 948 | " " |
| 4 | " " .. | 7 in. × 14 in | 38 ft. 0 in. | 1,242 | " " |
| 8 | " " .. | 7 in. × 14 in. | 40 ft. 0 in. | 2,613 | " " |
| 4 | " " .. | 7 in. × 14 in. | 18 ft. 0 in. | 588 | " " |
| 4 | " " .. | 7 in. × 14 in. | 8 ft. 0 in. | 264 | " " |
| 8 | Braces ... ..... | 12 in. × 14 in. | 26 ft. 4⅜ in. | 2,952 | " " |
| 8 | " .......... | 12 in. × 13 in. | 26 ft. 4⅜ in. | 2,742 | " " |
| 8 | " .......... | 11 in. × 12 in. | 26 ft. 4⅜ in. | 2,335 | " " |
| 8 | " .......... | 9 in. × 12 in. | 26 ft. 4⅜ in. | 1,890 | " " |
| 8 | " . ...... | 8 in. × 12 in. | 26 ft. 4⅜ in. | 1,688 | " " |
| 16 | Counters....... | 8 in. × 10 in. | 26 ft. 4⅜ in. | 2,810 | " " |
| 4 | " ....... | 8 in. × 10 in. | 14 ft. 0 in. | 374 | " " |
| 8 | Laterals........ | 6 in. × 8 in. | 20 ft. 8 in. | 662 | " " |
| 2 | " ........ | 6 in × 8 in. | 22 ft. 3⅜ in. | 180 | " " |
| 8 | " . .. ... | 8 in. × 8 in. | 19 ft. 3⅜ in. | 824 | " " |
| 6 | " .. . .. | 8 in. × 8 in. | 20 ft. 8 in. | 660 | " " |
| 2 | " ........ | 6 in. × 8 in. | 13 ft. 11¼ in. | 112 | " " |
| 2 | " ... ... | 8 in. × 8 in. | 13 ft. 11¼ in. | 150 | " " |
| 32 | Floor-beams .... | 9 in. × 16 in. | 19 ft. 4 in. | 7,424 | Spruce or Pine. |
| 6 | Stringers....... | 6 in. × 12 in. | 106 ft. 0 in. | 3,816 | " " " |
| 91 | Ties............ | 8 in. × 8 in. | 12 ft. 0 in. | .... | Oak. |
| 2 | Guard rails..... | 6 in. × 6 in. | 106 ft. 0 in. | 636 | Spruce or Pine. |
| 16 | Bolsters........ | 7 in. × 12 in. | 9 ft. 0 in. | 876 | " " " |
| 16 | Bridge-seats.... | 7 in. × 12 in. | 6 ft. 0 in. | 672 | " " " |
| 4 | Sills. ......... | 12 in. × 12 in. | 19 ft. 4 in. | 928 | " " " |
| 4 | Planks......... | 2 in. × 8 in. | 106 ft. 0 in. | 566 | " " " |
| 8 | Blocks........ | 2 in. × 8 in | 2 ft. 8 in. | 28 | Oak. |

*Wrought-Iron—Rods and Bolts.*

| No. | Description. | Diameter. | Length. | No. | Description. | Diameter. | Length. |
|---|---|---|---|---|---|---|---|
| 12 | Rods....... | 3 in. | 27 ft. 10 in. | 16 | Bolster b'lts | 1¼ in. | 2 ft. 4 in. |
| 12 | " ...... | 2¾ in. | 27 ft. 10 in. | 16 | " " | 1¼ in. | 3 ft. 4 in. |
| 12 | " ...... | 2½ in. | 27 ft. 10 in. | 220 | Chord bolts. | ¾ in. | 2 ft 9½ in. |
| 12 | " ...... | 2 in. | 27 ft. 10 in. | 48 | String'rb'lts | ¾ in. | 2 ft. 6 in. |
| 6 | " ... .. | 1¾ in. | 27 ft. 10 in. | 44 | T'k strg'b'ts | ¾ in. | 2 ft. 10 in. |
| 8 | Counters.... | 1 in. | 15 ft. 0 in. | 61 | Tie-bolts... | ¾ in. | 2 ft. 6 in. |
| 6 | Laterals.... | 1¾ in. | 20 ft. 0 in. | 20 | Brace-bolts. | ¾ in. | 2 ft. 9½ in. |
| 8 | " ... | 1½ in. | 20 ft. 0 in. | 64 | Spikes.. | ½ in. | 9 in. |
| 48 | Fl.beam b'ts | 1¼ in. | 3 ft. 0 in. | | | | |

*Other Iron Work.*

*Washers* (see Plate 120): 850 of pattern *F*; 176 of *G*; 40 of *H*.

*Castings* (see Plate 126): 36 of pattern *A*; 4 of *B*; 36 of *C*; 20 of *D*; 8 of *E*.

*Castings* (see Plate 121): 156 of pattern *L*; 156 of *M*; 64 of *O*; 32 of *P*; 64 of *Q*.

*Castings* (see Plate 117): 4 of pattern *F*; 96 of *I*.

No. 52. BILL OF MATERIAL FOR HOWE TRUSS BRIDGE. THROUGH SPAN, 120 FT. PLATE 127.

*Timber.*

| No. of Pieces. | Description. | Size. | Length. | Feet B. M. | Kind of Wood. |
|---|---|---|---|---|---|
| 24 | Top Chord...... | 7 in. × 12 in. | 24 ft. 1 in. | 4,044 | Yellow Pine. |
| 8 | " " ...... | 7 in. × 12 in. | 20 ft. 0¾ in. | 1,125 | " " |
| 8 | " " .. ... | 7 in. × 12 in. | 8 ft. 0⅛ in. | 449 | " " |
| 12 | Bottom Chord.. | 7 in. × 14 in. | 48 ft. 0 in. | 4,704 | " " |
| 4 | " " ...... | 7 in. × 14 in. | 45 ft. 0 in. | 1,470 | " " |
| 4 | " " ... .. | 7 in. × 14 in. | 33 ft. 0 in. | 1,078 | " " |
| 4 | " " ... .. | 7 in. × 14 in. | 21 ft. 0 in. | 686 | " " |
| 4 | " " ... .. | 7 in. × 14 in. | 9 ft. 0 in. | 294 | " " |
| 8 | Braces......... | 12 in. × 16 in. | 26 ft. 11⅝ in. | 3,456 | " " |
| 8 | " .. ....... | 12 in. × 15 in. | 26 ft. 11⅝ in. | 3,240 | " " |
| 8 | " ..... ... | 12 in. × 12 in. | 26 ft. 11⅝ in. | 2,592 | " " |
| 8 | " ......... | 10 in. × 12 in. | 26 ft. 11⅝ in. | 2,160 | " " |
| 8 | " .. ...... | 8 in. × 12 in. | 26 ft. 11⅝ in. | 1,728 | " " |
| 16 | Counters.... ... | 8 in. × 10 in. | 26 ft. 11⅝ in. | 2,880 | " " |
| 4 | " ....... | 8 in. × 10 in. | 14 ft. 6 in. | 386 | " " |
| 4 | Laterals........ | 6 in. × 8 in. | 20 ft. 9 in. | 332 | " " |
| 2 | " .... ... | 6 in. × 8 in. | 22 ft. 4 in. | 180 | " " |
| 8 | " .. ..... | 6 in. × 8 in. | 17 ft 11½ in. | 576 | " " |
| 4 | " ....... | 10 in. × 10 in. | 21 ft. 7 in. | 720 | " " |
| 10 | " ........ | 8 in. × 8 in. | 22 ft. 4 in. | 1,200 | " " |
| 2 | " ........ | 6 in. × 8 in. | 13 ft. 11¼ in. | 112 | " " |
| 2 | " ......... | 8 in. × 8 in. | 13 ft. 11¼ in. | 150 | " " |
| 32 | Floor-beams.... | 9 in. × 16 in. | 19 ft. 4 in. | 7,424 | Spruce or Pine. |
| 6 | Stringers... ... | 6 in. × 12 in. | 126 ft. 0 in. | 4,536 | " " " |
| 108 | Ties............ | 8 in. × 8 in. | 12 ft. 0 in. | .... | Oak. |
| 2 | Guard-rails..... | 6 in. × 6 in. | 126 ft. [illegible] in. | 756 | Spruce or Pine. |
| 16 | Bolsters...... .. | 7 in. × 12 in. | 9 ft. 0 in. | 1,008 | " " " |
| 16 | Bridge-seats.... | 7 in. × 12 in. | 6 ft. 0 in. | 672 | " " " |
| 4 | Sills............ | 12 in. × 12 in. | 19 ft. 4 in. | 928 | " " " |
| 4 | Planks......... | 2 in. × 8 in. | 126 ft. 0 in. | 672 | " " " |
| 8 | Blocks......... | 2 in. × 8 in. | 2 ft. 8 in | 29 | Oak. |

*Wrought-Iron—Rods and Bolts.*

| No. | Description. | Diameter. | Length. | No. | Description. | Diameter. | Length. |
|---|---|---|---|---|---|---|---|
| 12 | Rods... ... | 2¾ in. | 27 ft. 10 in. | 64 | Fl.beam b'ts | 1¼ in. | 3 ft. 0 in. |
| 32 | " . ..... | 2½ in. | 27 ft. 10 in. | 232 | Chord-bolts. | ¾ in. | 2 ft. 9½ in. |
| 18 | " ....... | 2 in. | 27 ft. 10 in. | 48 | String'rb'lts | ¾ in. | 2 ft. 6 in. |
| 8 | Counters... | 1 in. | 15 ft. 0 in. | 44 | T'kstr'g'b'ts | ¾ in. | 2 ft. 10 in. |
| [illegible] | Laterals.... | 1¾ in. | 20 ft. 0 in. | 72 | Tie-bolts. | ¾ in. | 2 ft. 6 in. |
| 8 | " ... | 1½ in. | 20 ft. 0 in. | 36 | G'rd-r'l-b'lts | ¾ in. | 1 ft. 3 in. |
| 16 | Bolster b'lts | 1¼ in. | 2 ft. 4 in. | 20 | Brace-bolts. | ¾ in. | 2 ft. 9½ in. |
| 16 | " " | 1¼ in. | 3 ft. 4 in. | 80 | Spikes...... | ½ in. | 9 in. |

*Other Iron Work.*

*Washers* (see Plate 120): 950 of pattern *F*; 208 of *G*; 32 of *H*.

*Castings* (see Plate 128): 28 of pattern *A*; 8 of *B*; 24 of *C*; 8 of *D*.

*Castings* (see Plate 126): 4 of pattern *B*; 28 of *C*; 8 of *F*.

*Castings* (see Plate 121): 156 of pattern *L*; 152 of *M*; 64 of *O*; 32 of *P*; 64 of *Q*.

*Castings* (see Plate 117): 8 of pattern *F*; 96 of *I*.

126 and 128. Reference is also made to plates recently published for some of the castings required.

The bills of materials for both spans are also given herewith, and with the plates present all that is needed to give information concerning the designs.

These two close the series of designs for Howe truss bridges, which have necessarily been extended over some time, owing to the space required for the plates.

(TO BE CONCLUDED.)

## THE MANNESMANN TUBES.

AT the recent meeting of the Iron & Steel Institute in Pittsburgh, much attention was excited by the display of tubes made by the Mannesmann process, which accompanied the paper read by Dr. Hermann Wedding on the process, which was invented by the brothers Reinhard and Max Mannesmann, of Remscheid, Germany.

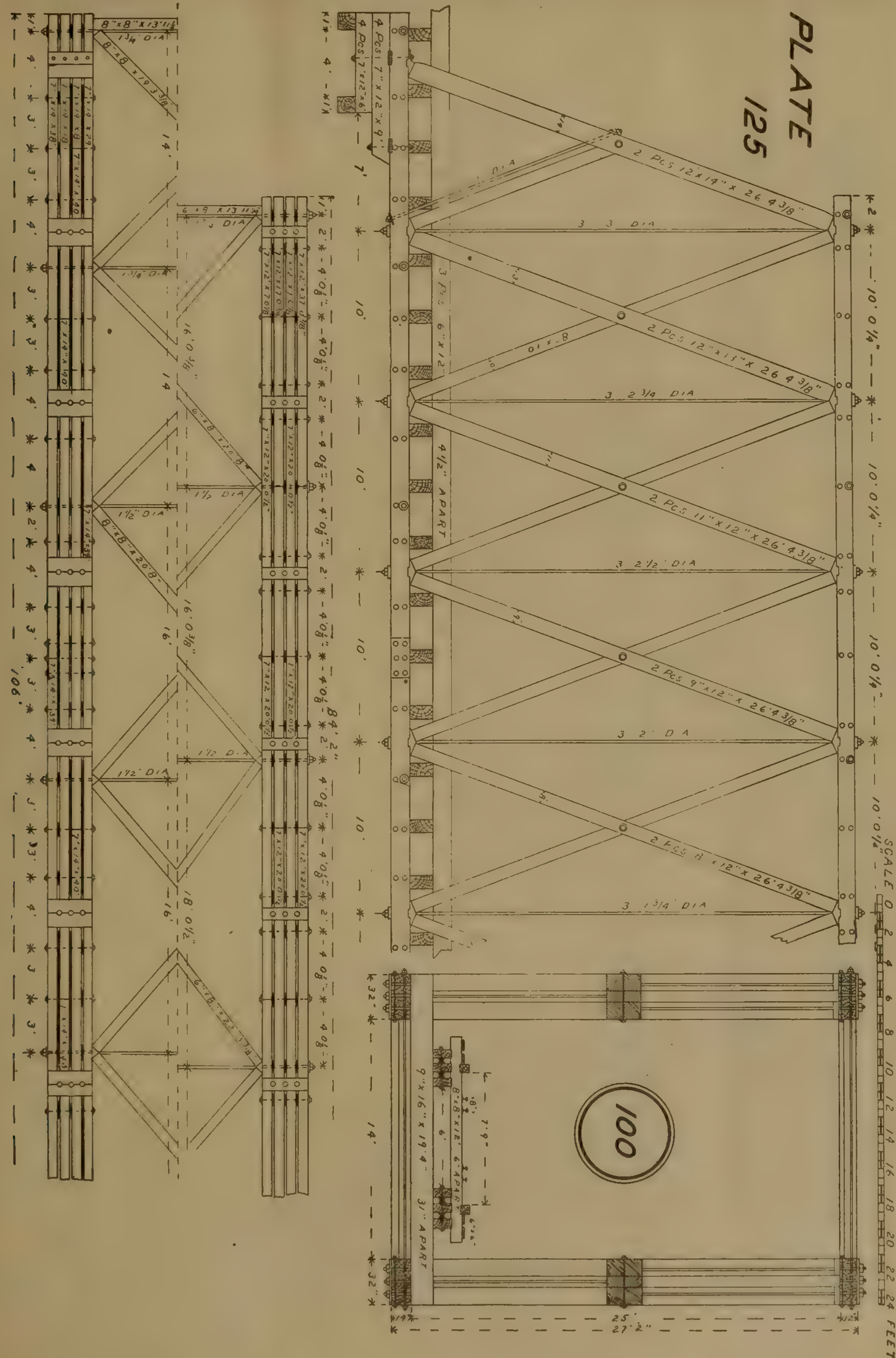
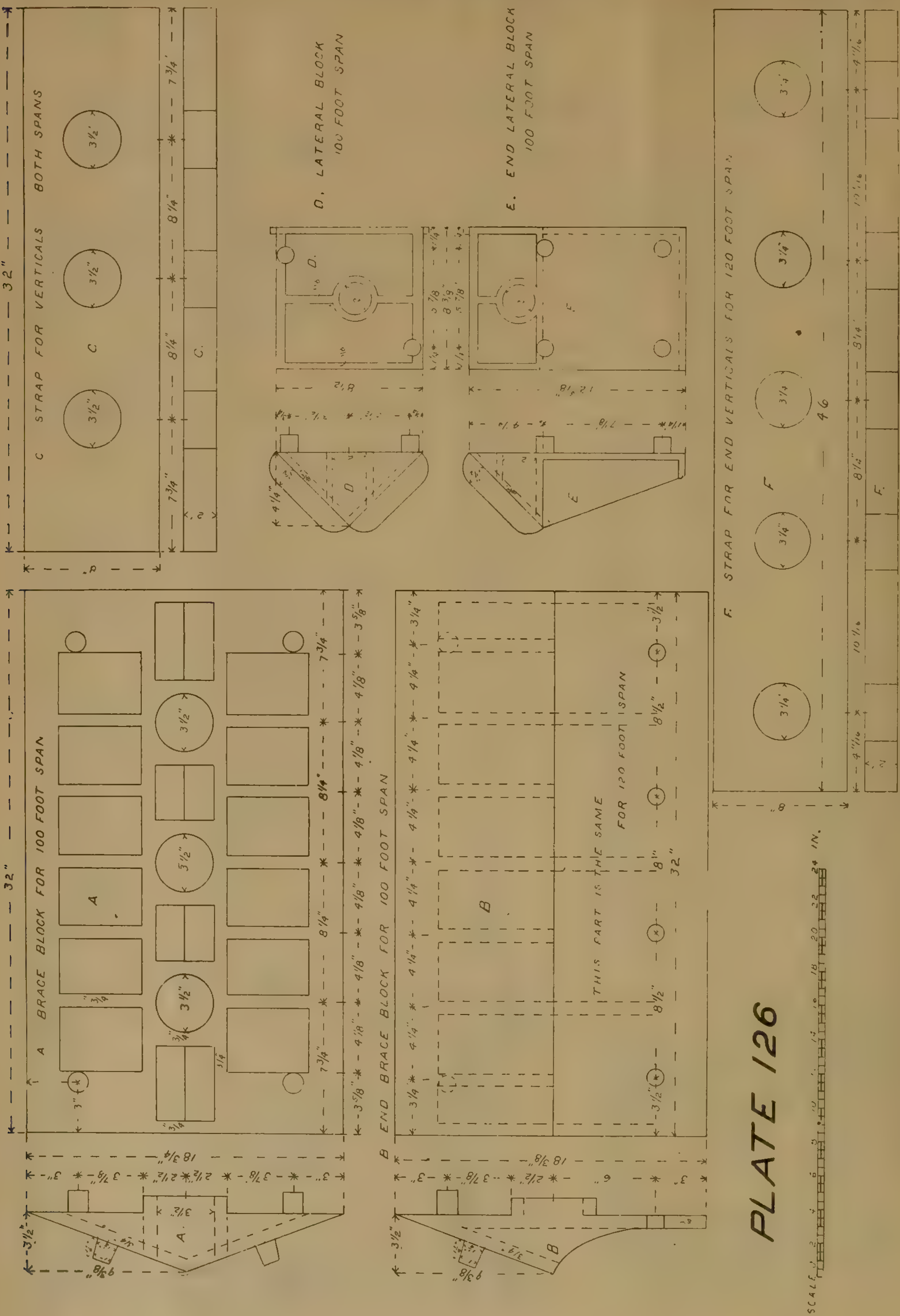


PLATE
125
100
SCALE
FEET


C STRAP FOR VERTICALS BOTH SPANS
D. LATERAL BLOCK 100 FOOT SPAN
E. END LATERAL BLOCK 100 FOOT SPAN
F. STRAP FOR END VERTICALS FOR 120 FOOT SPAN
A BRACE BLOCK FOR 100 FOOT SPAN
B END BRACE BLOCK FOR 100 FOOT SPAN
THIS PART IS THE SAME FOR 120 FOOT SPAN
PLATE 126
SCALE IN.

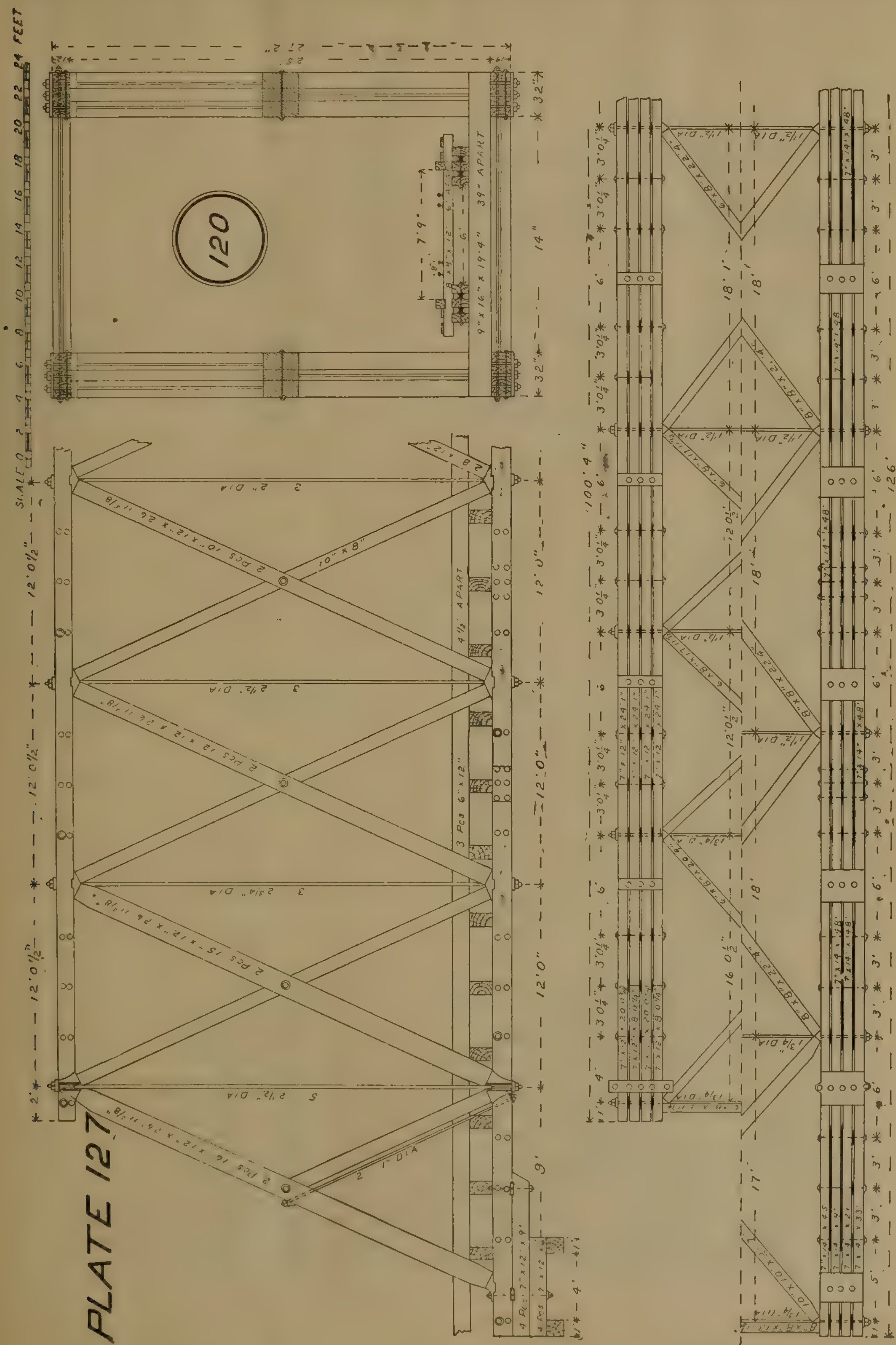


PLATE 127

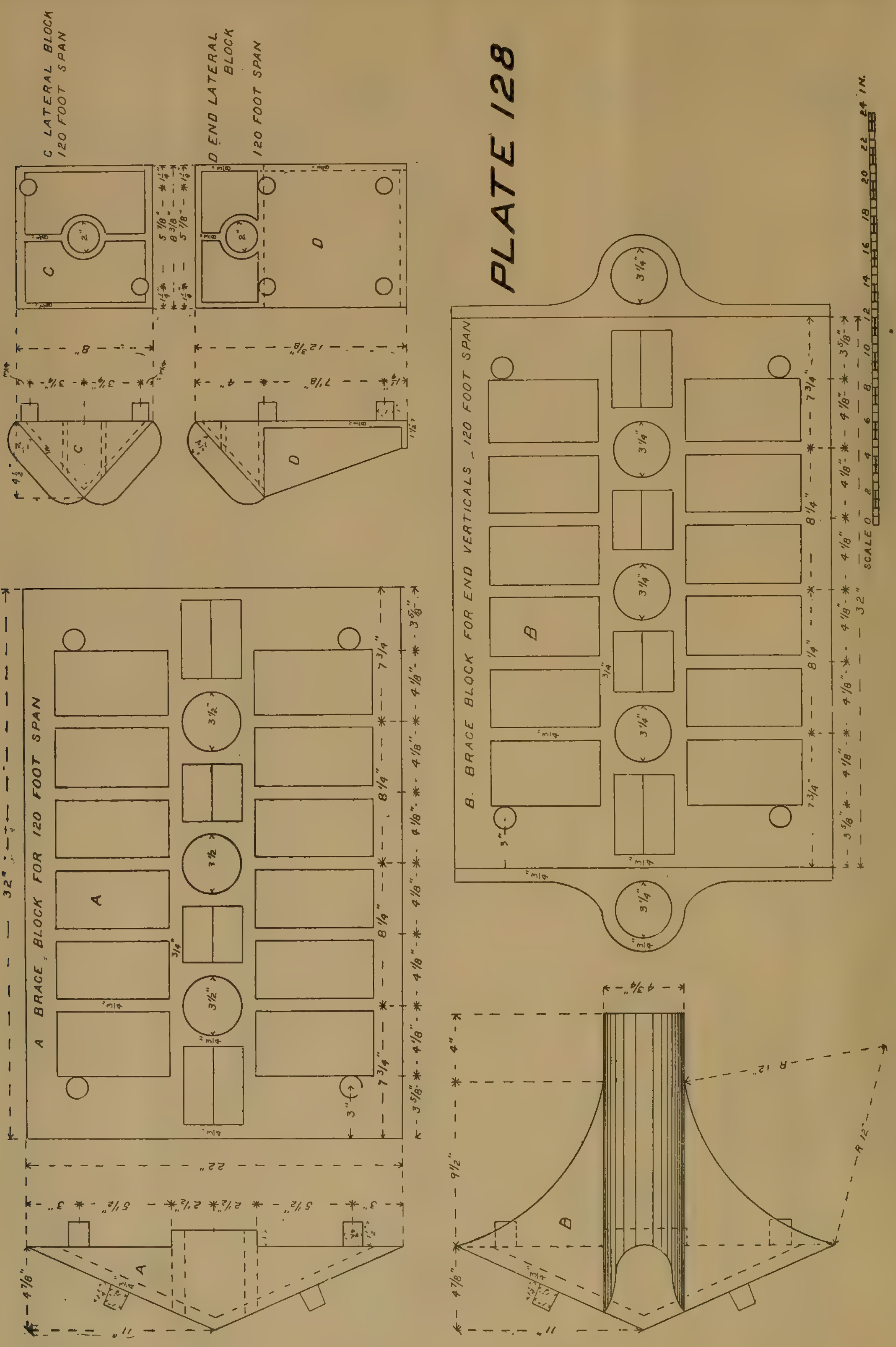


PLATE 128
C LATERAL BLOCK 120 FOOT SPAN
D END LATERAL BLOCK 120 FOOT SPAN
A BRACE BLOCK FOR 120 FOOT SPAN
B BRACE BLOCK FOR END VERTICALS 120 FOOT SPAN
SCALE 0 2 4 6 8 10 12 14 16 18 20 22 24 IN.

This method is of special use in the making of pipes designed to withstand heavy pressures, and must be regarded as an important improvement. It is a departure from previous practice in such manufacture well calculated to work a revolution in the methods of manufacturing, as well as the results obtained, which are most remarkable. The process consists in feeding a solid, heated bar of ingot metal between rolls, which, while their axes are oblique to the axis of revolution, revolve both in the same direction. The metal of the surface of the bar thus acquires an increased motion in a spiral direction, and is drawn over its core, receiving consequently the form of a pipe. Since, in this operation, the pipe moves spirally forward, and all its parts are spirally pushed and pressed the metal becomes still denser. It is this spiral arrangement of the metal which makes the Mannesmann pipes so remarkable, quite apart from the advantage they possess in presenting no lines of welding whatever. Moreover, blowholes (which are invariably present in ingot iron) are so squeezed out spirally as to make the walls of the pipe completely impermeable. A proof of this is the retention of hydrogen for weeks in a piece of Mannesmann pipe, closed at both ends. Pipes thus made and enlarged have been successfully produced of all diameters up to 18 in.

The designing of the machinery for making these tubes was a work of some difficulty, on account of the very high speeds required for the rolls, and the details of this machinery have so far been kept secret.

In addition to the rolls in making the tubes, a mandrel may be used, improving the product, in that the pipe is at once made smooth and more nearly perfect inside than would be the case otherwise.

The proportion of the inside diameter or bore of the tube may be varied within wide limits. In work thus far done, it has been possible to make a tube, say of $1\frac{1}{2}$ in. outside diameter, with a bore not larger than a small wire, say $\frac{1}{16}$ in., and in contrast to such tubes, pipes are regularly made by this process having an area of bore equal to 95 per cent. of that of the outside measurement, and even this, it is claimed, may be readily exceeded if occasion should demand, as experiments which have been made clearly demonstrate.

The pipes are made in the ordinary lengths, 18 to 23 ft.; they have, however, been turned out in lengths of 45 ft. and upward, thus insuring a considerable decrease in the number of connecting pieces required.

Tubes made by this process have been tested up to pressures of 4,500 lbs. per square inch. It has been found possible to roll a tube of a given length with the walls thicker at the middle than at the ends, and then, by making such tubes of rectangular or other desired section by re-rolling, to make beams or girders of constant strength, this being effected by making the billet from which the tube is to be rolled of less section in the middle than at the ends at the beginning of the process.

The use of Mannesmann tubes for all purposes where great strength, combined with lightness and absolute homogeneity of metal, as for car axles and similar uses, has been suggested. It has been found in the experiments which have been made that an inferior metal, one not perfectly homogeneous in its composition and quality, will not stand the test of being put through the Mannesmann rolls, that it is entirely impossible to form a tube out of imperfect material. This being the case, the very fact that a tube has been formed by this method, it is claimed, is of itself at once a guarantee of the quality of the material used, and gives in the product a degree of safety in use never before attained.

Regarding the physical structure of tubes made by this process, Dr. Wedding has found, in the examinations he has made with the microscope, that the metal shows a very distinct spiral structure. The tubes of cast steel have a number of extremely minute gas bubbles which wind through the metal, following closely the direction of the fibers. The presence of these spaces does not appear materially to affect the strength of the pipe, since the tests show more than double the strength of similar wrought-iron tubes.

There are now manufactories of these tubes at Kotomau in Bohemia, Bous and Remscheid in Germany; and the Mannesmann Tube Company has recently completed a large factory at Landore, Wales. It is stated that arrangements are in progress to establish a factory in this country.

## OUR NAVY IN TIME OF PEACE.

By Lieutenant Henry H. Barroll, U. S. N.

The first duty of our Navy in time of peace is naturally to keep its ships and *personnel* constantly prepared for war. The mere fact of being at all times ready will often avert the aggression of a foreign power.

It is not only necessary that we should at all times have the most modern vessels of war, but, in order that these shall be most effective, it is in time of peace that they should be built, when time and care can be taken for their more perfect construction.

War is a state or condition of things for which peace furnishes the drill-hour; and therefore in time of peace there is no service upon which our Navy can be so profitably engaged as in the perfecting of its fighting powers.

A naval force should be constantly ready for active service. Increased speed on the high seas, while bringing the nations of the world closer together as regards travel and commerce, has also brought them nearer for the purpose of waging warfare; and campaigns which in former times would have necessitated months of preparation, now require only a few weeks at most for their decisive results to be attained.

It requires constant study to keep pace with the rapid changes made in the art of war. Each great national conflict greatly modifies the systems of warfare. The American civil war of 1861–65 was fought almost entirely without machine guns, which less than 10 years later played so important a part in the struggle between France and Prussia. The iron-clad monitor of Ericsson revolutionized the navies of the world. The torpedo, which in our civil war was first brought prominently to the front (despite the emphatic protest of all foreign powers that its use was contrary to the Law of Nations), is now recognized as a military arm of highest importance; and all nations are striving to obtain the most destructive—the most annihilating type of this species of weapon.

Torpedoes were used sparingly and with only approximate success during the Rebellion, but were the right arm of the Prussian defense of the harbors of the North and Baltic Seas, preventing the French from using their highly efficient fleet. Later, the attack upon the stationary submarine mine by counter-mining—the explosion of counter-torpedoes—has led to the invention of finer machines; and the automobile torpedo is temporarily supreme, until a more formidable rival shall have been launched upon the world, only to be defeated in its turn, as its predecessors have been, by the study and inventive powers of the nation's defenders. No person can now prophesy what will be the effect, during the next war, of the use of the lately invented smokeless powder; while there is no question but that balloons will play an important part in the settlement of the next national conflict.

War has now become so expensive that it will not be resorted to until other means of settlement have failed. Sober second-thought or arbitration will be called upon to avert it; and, except with those smaller States which have not much at stake, differences are even now generally settled in this way. Still, nowithstanding the many advocates of Courts of Arbitration, Universal Peace Associations, and other Utopian societies, war will continue to be the "last resort of kings," and even now, as in the day of the First Napoleon, victory will be on the side of that nation having the heaviest artillery.

A modern man-of-war has very few points in common with those vessels engaged in mercantile pursuits; and it is not now possible, as it was in the day of the glorious *Essex*, to readily turn captured merchantmen into fighting ships.

Fortunately, the geographical position of the United States removes us from many of the conflicting questions which are continually causing apprehension to the several European States; while the fact that America is composed

principally of republics relieves us from having to keep constantly armed, as does our sister republic, France, against a possible coalition of land-grabbing monarchies.

Yet, while it is unnecessary that our country should be burdened with a navy of such vast proportions as those belonging to European powers of corresponding magnitude, it is equally improvident to allow it to deteriorate to an inefficient condition.

It is hardly likely that any nation would in the present day attempt to invade our coast further than to obtain a foot-hold, and a line of possession extending perhaps a few miles inland from tide-water. Such an invasion as that made by the British in 1814, when our public buildings at Washington were burned and our national records were committed to the flames, will hardly be attempted in the face of our greater strength, and the more improved methods of defense.

The number of vessels to carry provisions and ammunition for an invading army would constitute a fleet of greater proportions than any one nation could assemble. Our remoteness from the European countries removes us from invasion, as the "silver streak" of the English Channel has defended Great Britain from her continental rivals.

But while this isolation furnishes us a safeguard against invasion such as that of the British in 1814, there is not now the need of such invasion to cause an equally severe amount of destruction. With the long-range guns of the present day there is no reason for landing within the limits of a hostile country, when better results can be obtained from a safer position.

The fighting power, as now carried in modern war-ships, does not need to land to make itself felt; while with such glaring examples before us as the burning of the Summer Palace at Peking, the enforcement of opium upon the Chinese people, the bombardment of Valparaiso, Alexandria, etc., and the wholesale murder of Chinese in the River Min, we must admit that civilization has not yet been successful enough to demand of civilized nations immunity for non-combatants from the desolations caused by war.

Although the best authorities on the subject of international law have repeatedly affirmed that undefended cities are to be considered as exempt from bombardment, yet this principle has repeatedly been and will continue to be disregarded. It is therefore imperative that no matter how strong we may be by land—no matter how impossible it may be to invade our Western States—we should have a naval force at least sufficient to prevent a foreign foe from taking up an unchallenged position from which he may best destroy our seaboard cities, or demand from them their full value in ransom.

It is also a mistake to suppose that, owing to our isolated position as regards European powers, we may not be required to take up arms in defense of some foreign question.

Two generations ago President Monroe announced his famous Doctrine, which is now so often alluded to, and one principle of which was to the effect that American territory was no longer susceptible of colonization (colonization being another European term for seizure) by European Powers.

This principle has never been admitted by the European powers themselves; it is likely that it never will be admitted; and the probability is that our being allowed to expatiate upon it so long arises from the jealousies existing among themselves, rather than from any fear on the part of the European governments that we will attempt its enforcement. Even if we once attempted to prevent the interference of those foreign powers in the affairs of American republics, we would possibly have at times to hold the principle in abeyance, as the English now do their insistance on the Right of Search, which was so strenuously held to in former times.

Although the Monroe Doctrine has never been admitted by the European powers, yet so far these have avoided bringing that question to a definite settlement. We have so long advanced it that we could not now honorably neglect to insist upon its observance should the necessity of maintaining its principles arise; and although removed by thousands of miles from European complications, yet the control of the Pacific is a matter of vital importance to the United States; and we will be brought face to face with this question when the Nicaragua Canal nears completion.

The control of this important channel-way must perforce excite the cupidity of some of our friends across the sea. Aden, Perim, Malta, Hong Kong, Tongking, Belize, Cyprus, Suakin, Tahiti, Madagascar, Zanzibar, Massowa, even Egypt, have been colonized (?), bought (?), or protected (?), for far less important reasons!

With regard to a canal across the American Isthmus, the President of the United States said in his annual message of 1880:

> The policy of this country is a canal under American control. The United States cannot consent to the surrender of this control to any European power. The capital invested by corporations or citizens of other countries in such an enterprise must, in a great degree, look for protection to one or more of the great powers of the world. No European power can intervene for such protection without adopting measures on this continent which the United States would deem wholly inadmissible.

Bermuda, that thorn in the Atlantic side of our continent, is of more value to the United States as a strategic point than the entire State of Ohio; and we cannot afford to allow the Sandwich Islands also to pass under European control.

Such reflections serve to make it apparent that, notwithstanding the peaceful character of our nation—notwithstanding our isolated position—notwithstanding our well-known aversion to having foreign possessions, we may, from some such cause, at any moment have quarrels forced upon us; and therefore, in time of peace, as well as in actual warfare, our Navy must be exercised to the highest point of efficiency, and eternal vigilance must still be the price of our liberty.

Having a smaller force than those navies against whom it may be opposed does not diminish, but further accentuates the importance of keeping that force composed of the most modern type of vessels. We must be able to compensate by excellence for our disadvantage in point of numbers. This must be done by constant drill and study. Indeed, the experience of our late civil war demonstrated that there was less need for drills in time of war than during peace. In time of peace, drill is necessarily only a sham affair—the rehearsing of the real tragedy which is afterward to be enacted—and it is, therefore, all the more important that the rehearsals be frequent and well-attended, that the tragedy may be a complete success; but when the company is giving daily exhibitions, private rehearsals are no longer necessary.

It requires from four to five years, with the best plant which our country affords, to build and equip a modern battle-ship, and almost as long to drill into thorough efficiency the crew who are to conduct her into action and fight her guns. With the nucleus which our present Navy furnishes, crews could be drilled into comparative efficiency in less time; but that raw recruits can in so short a time be even partially instructed in their various duties is due to the fact that their drill-masters—graduates of the United States Naval Academy—have been dozens of years acquiring the knowledge which they impart.

There are, then, certain individuals whom the nation cannot afford to discharge in time of peace, because the knowledge and skill which they possess can only be obtained after years of experience and drill.

This necessity of retaining at all times the most skilled men, in a military point of view, extends from the cabin to the forecastle. There are experienced commanders and expert gunners; thorough electricians and skilful coxswains of boats, all well-trained men in their several callings; and although the captain commands the gunner, the coxswain, and the torpedo officer, it does not necessarily follow that he can steer a boat, direct a torpedo, or aim an 8-in. gun with the same skill or precision as can that man who has been found to be specially qualified for that particular business.

In addition to having this technical knowledge, it is also of importance that a person should have, if possible, constant practice in those affairs which he is expected to execute; and during those long periods of peace, which are best for our country in a mercantile point of view, the mili-

tary power naturally deteriorates unless still greater efforts are made to keep it efficient.

The wealth, resources, and abilities of our country would go far toward supplying our want of preparation, but could not obviate the lapse of time necessary to construct the proper means of defense. It is a mistake to rely upon the naval defense of the country by its untrained citizens.

Thirty years of rest, while foreign powers have been supplying themselves with modern ships and improved weapons of war, have placed us now where it behooves each of us to think over and study out the best plans for that defense.

Cincinnatus was suddenly called from the plow to command an army; but Cincinnatus, or even Lord Nelson, for that matter, would have a sorry time of it if suddenly called upon to command the *Philadelphia*, and meet a well-drilled antagonist.

In 1874 Spanish insurgents, then in possession of the city of Carthagena, on the Mediterranean coast of Spain, managed to get to sea with the two Spanish men-of-war, the *Almanza* and the *Vittoria*, but were promptly captured in the Mediterranean, one by an English and the other by a German man-of-war, and were brought back to Escombrera Bay before they had any chance to put their peculiar theories into practice.

One of these insurgent vessels was commanded by a butcher, with an actor as first-lieutenant; and among other amusing incidents connected with their short cruise, shell were found in several of the guns, with no cartridges behind; a small 5-in. shell was found rammed carefully home in an 8-in. gun, while the larger shell had been left in despair, beside the more diminutive 5-in. rifle.

Owing to dissensions, the insurgents decided to surrender to the English and German men-of-war, else there might have been a parallel to the target-practice of the magnificent French fleet against the poorly officered, miserably manned and totally undrilled Chinese wretches in the River Min.

The prosperity of our Navy and that of our merchant marine must go hand in hand, for we can never expect to have an effective naval force so long as the majority of our seamen are drawn from foreign sources. We cannot expect these to have the interest of our country or the honor of our flag very close to heart; and although they can be made to fight through a war, yet it will generally be found that they have enlisted to "fight" only on a peace basis.

We are essentially a land-dwelling people—not an amphibious race such as the Norseman or Dane—and could raise to a corresponding degree of efficiency a powerful army in a much shorter time than that in which we could produce a formidable navy.

In event of sudden war, our Army would at once be re-enforced in both rank and file from a comparatively well-drilled militia. The Navy, for its increase under similar circumstances, would be dependent almost altogether upon the fishing fleet, since our American merchant vessels are manned almost entirely by foreign seamen. Even those additions that might be made from the above sources would be composed of men who, although possibly good sailors, would be utterly ignorant of the military duties of a man-of-wars-man.

The foregoing presents the *raison d'être* of a navy in time of peace—not only to retain, but to increase its efficiency for war; not only to keep in thorough working condition the splendid modern battle-ships, but to also design, build and equip vessels which shall combine the latest and most destructive fighting qualities; not only to keep ourselves, by constant exercise, in thorough practice, but by patience and care to evolve from the raw recruit a well-drilled, well-informed, and well-disciplined soldier *and* sailor.

FIG. 1. ELEVATION AT RAIL LEVEL


FIG. 2. PLAN AT ROAD LEVEL

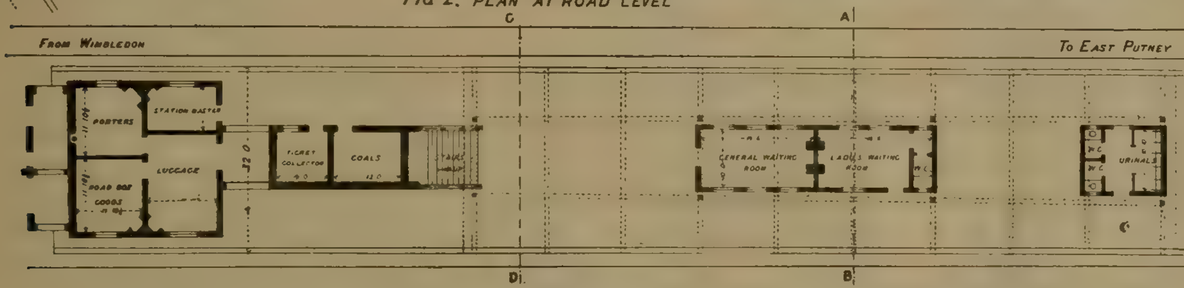



FIG. 3. PLAN AT RAIL LEVEL

AN ENGLISH SUBURBAN STATION.

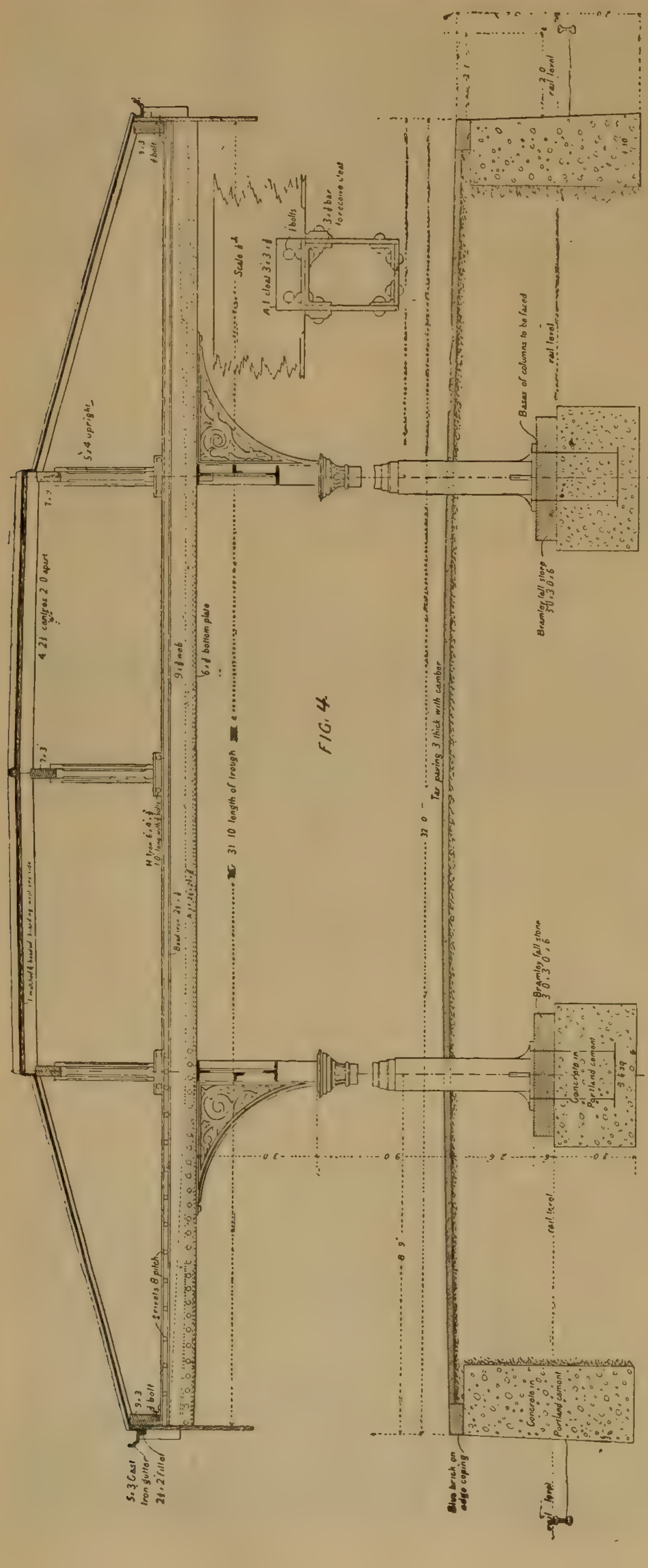


FIG. 4

PLATFORM AND ROOF OF SUBURBAN STATION, LONDON & SOUTHWESTERN RAILWAY.

This paramount duty of the Navy being provided for—this end being accomplished — the surplus individuals or vessels belonging to the Navy may be and are employed in various ways to further benefit commerce, etc., while they are not wanted for actual warfare.

(TO BE CONTINUED.)

## AN ENGLISH SUBURBAN STATION.

THE accompanying illustrations, from the *Railway Engineer*, show a very neat suburban station recently built on the new Wimbledon Branch of the London & Southwestern Railway. The one illustrated is at Wimbledon Park, but others on the line are of similar type, with such variations as are required by local circumstances. Figs. 1, 2, and 3 show a side elevation, a roof plan, and a floor plan of the station, while fig. 4 shows the construction of the roof more in detail. In this case it will be seen that the adjoining public street is at a higher level than the track. The ticket office, or booking office, as our English cousins call it, is on a level with the road, and after passing it passengers descend a staircase to the level of the platform, upon which the waiting-rooms are situated. This seems to be a much better arrangement than to have the waiting rooms upon the higher level, as passengers are then close to the track platforms and are not dependent upon warnings sent from a distance to notify them when the train is coming.

In this case the platform is in the center, with the track on each side of it. This is not always the best arrangement, but has the advantage of saving bridges or other arrangements for crossing the track. The baggage-rooms are on a level with the platform, and a hydraulic elevator is provided for carrying baggage and parcels up and down.

The buildings are of brick with facings of stone, the roof being tiled. The platform roof is carried on cast-iron columns placed 40 ft. apart, carrying wrought-iron lattice girders and trough girders which support the roof timbers. The roof is of boards covered with zinc. The rain-water is carried from the gutter placed at the eaves by means of the trough girders into the columns, down which it passes and is then carried into a sewer under the platform. The platforms are paved with tar and gravel under the roofing. The signal-box is placed at the end of the platform.

The general construction and arrangement of the roof trusses and the roof is shown in fig. 4. The longitudinal girders which are carried on the iron columns are lattice girders, each 39 ft. 5 in. in length and 24 in. in depth, the top and bottom chords being of T-iron. The roof timbers, which are carried on the trough girders resting on the truss, are 9 × 3 in. in size and the ridge timber 7 × 3 in. The roof rafters, which are placed 2 ft. apart centers, are 4 × 2½ in. in size. The cast-iron columns rest upon concrete foundations provided with a capstone to receive the base of the columns, the top of the capstone being about 2 ft. below the platform level.

## THE UNITED STATES NAVY.

THE new gun boat *Bennington*, which is a sister ship to the *Concord*, is to have considerable alterations made in her. The chief of these is the addition of a flush spar deck extending the whole length of the ship, and the substitution of two masts for three. The effect will be to give her more stability and make her a better sea boat. The changes are the result of experience with the *Yorktown* as a cruiser. A change in the battery will be made also, and instead of six 6-in. guns, the *Bennington* will have eight 5-in. guns, four mounted amidships, two forward and two aft. With these changes it is believed that she will be a more efficient cruiser, while her armament will be quite as formidable as that originally planned. These changes will somewhat delay the completion of the ship.

### THE SECRETARY'S REPORT.

The report of the Secretary of the Navy gives an extended account of the progress so far made in building up a navy composed of vessels of the best modern types. Under existing contracts nearly all the vessels so far planned will be completed by 1893. All of those under construction have been from time to time described in our columns, and in the accompanying table are given all the new ships, the construction of which has so far been authorized by Congress, the present condition of each being briefly noted.

Hardly less important than the work of building new ships is that of supplying them with guns. The following table gives the number of sets of forgings so far ordered, the number of guns completed, and the number of guns now under construction at the Washington Gun Foundry :

| Caliber. | Forgings Ordered. | Completed Guns. | Guns under Construction. |
|---|---|---|---|
| 4-in. | 35 | 4 | 12 |
| 5-in. | 4 | ■ | .. |
| 6-in. | 128 | 77 | 25 |
| 8-in. | 35 | 15 | 2 |
| 10-in. | 25 | 4 | 3 |
| 12-in. | 8 | .. | .. |
| 13-in. | 12 | .. | .. |

Of the above guns, the 4-in. and 5-in. may properly be classed as rapid-firing guns, employing fixed ammunition, that is to say, having the cartridge case, charge, and projectile combined in one. The 5-in. gun is the largest that present investigation and experience indicate as properly adapted to the quick-firing feature. The combined weight of the cartridge case, charge and projectile in this gun is estimated not to exceed 100 lbs., which can be handled without difficulty. Beyond this it is inexpedient to go, as the great weight of the projectile prevents the rapidity of fire, which is this gun's essential feature. A specimen of the 4-in. gun has been completed and tried and has given highly satisfactory results, two types, differing in their breech mechanism, having been manufactured.

The adoption of rapid-firing guns of large caliber has made it necessary to develop a plant for the manufacture of suitable cartridge cases, and an agreement has accordingly been made with the Winchester Repeating Arms Company of New Haven, Conn., to supply 15,000 cases, with the option to the department to order 10,000 more at a reduced price. The company has nearly completed the machinery necessary for making these cases, and their delivery will soon begin.

Passing to the heavy guns, the first is the 6-in., the length of which has been increased from 30 to 35 calibers. The performance of the new gun is satisfactory, and specimens will soon be made with a still longer bore, a gun 40 calibers in length having been designed for this purpose.

Of the 8-in. guns, six of the new designs, 35 calibers in length, have been manufactured, tested with good results, and issued, and a new 8-in. gun, 40 calibers in length, has been designed which it is proposed to mount on Cruiser No. 12. The great advantage of this gun, as of all long guns, is the flat trajectory of the projectile, due to its high velocity, which makes it possible to use the gun successfully at ordinary battle range without accurate measurement of distance.

Of the 10-in. guns, four that make up the armament of the *Miantonomoh* are completed, and three of the four for the *Maine* are in an advanced stage of manufacture.

No 12-in. guns have yet been made, but forgings for one gun have been received from the Bethlehem Iron Company, and the gun factory is ready to proceed with the manufacture of these guns as fast as forgings are delivered.

The design for the first 13-in. gun, 35 calibers in length, has been completed, and the tools for its manufacture are in course of construction. Twelve sets of forgings of this size have been ordered from the Bethlehem Iron Company for the batteries of the three new battle ships.

All contracts with private firms for the manufacture of heavy guns have been completed in the course of the past

NEW SHIPS FOR THE UNITED STATES NAVY.

| Vessel. | Description. | Displacement, Tons. | Condition. |
|---|---|---|---|
| Armored Ships. | | | |
| First Rate : | | | |
| 1. *New York* | Cruiser | 8,100 | Bldg. Cramp & Sons, Phila. |
| 2. *Maine* | Cruiser | 6,648 | Launched, N. Y. Navy Yard. |
| 3. *Texas* | Battle-ship | 6,314 | Bldg. Norfolk Navy Yard. |
| 4. *Puritan* | Monitor | 6 060 | Building, N. Y. Navy Yard. |
| 5. *Indiana* | Battle-ship | 9,900 | Bldg. Cramp & Sons, Phila. |
| 6. *Massachusetts* | Battle-ship | 9,900 | Bldg. Cramp & Sons, Phila. |
| 7. *Oregon* | Battle-ship | 9,900 | Bldg. Union I. W., San Fran. |
| Second Rate : | | | |
| 8. *Monterey* | Monitor | 4,003 | Bldg. Union I. W., San Fran. |
| 9. *Amphitrite* | Monitor | 3,815 | Under com., N'f'k N. Yard. |
| 10. *Miantonomoh* | Monitor | 3,815 | Under com., N. Y. N. Yard. |
| 11. *Monadnock* | Monitor | 3,815 | Under com., M. Is'd N. Yard. |
| 12. *Terror* | Monitor | 3,815 | Under com., N. Y. N. Yard. |
| Third Rate : | | | |
| 13. Harbor Defense Ram | Armored Ram | 2,000 | Bids ca'ed for, op'ed Dec. 20. |
| Unarmored Ships. | | | |
| First Rate : | | | |
| 14. Cruiser No. 6 | Cruiser | 5,500 | Bldg. Union I. W., San Fran. |
| 15. Cruiser No. 12 | Cruiser | 7,400 | Bldg. Cramp & Sons, Phila. |
| Second Rate : | | | |
| 16. *Chicago* | Protected Cruiser | 4,500 | In commission. |
| 17. *Baltimore* | Protected Cruiser | 4,400 | In commission. |
| 18. *Philadelphia* | Protected Cruiser | 4,300 | In commission. |
| 19. *Newark* | Protected Cruiser | 4,083 | Ready for trial. |
| 20. *San Francisco* | Protected Cruiser | 4,083 | Nearly ready for sea. |
| 21. *Charleston* | Protected Cruiser | 3,730 | In commission. |
| 22. *Boston* | Cruiser | 3,189 | In commission. |
| 23. *Atlanta* | Cruiser | 3,189 | In commission. |
| 24. *Cincinnati* | Cruiser | 3,000 | Building, N. Y. Navy Yard. |
| 25. *Raleigh* | Cruiser | 3 000 | Bldg. Norfolk Navy Yard. |
| Third Rate : | | | |
| 26. Cruiser No. 9 | Cruiser | 2,000 | Bldg. Columbian I. W., Bal. |
| 27. Cruiser No. 10 | Cruiser | 2,000 | Bldg. Columbian I. W., Bal. |
| 28. Cruiser No. 11 | Cruiser | 2,000 | Building, H. Loring, Boston. |
| 29. *Bennington* | Gunboat | 1,700 | N'ly r'y, R'ch y'd, Ch'ter, Pa. |
| 30. *Concord* | Gunboat | 1,700 | R'y for tr'l, R'ch y'd Ch., Pa. |
| 31. *Yorktown* | Gunboat | 1,700 | In commission. |
| 32. *Dolphin* | Gunboat | 1,485 | In commission. |
| 33. Gunboat No. 5 | Gunboat | 1,050 | Bldg. Bath I. W., Bath, Me. |
| 34. Gunboat No. 6 | Gunboat | 1,050 | Bldg. Bath I. W., Bath, Me. |
| Fourth Rate : | | | |
| 35. *Vesuvius* | Dynamite Gunboat. | 970 | In commission. |
| 36. *Petrel* | Gunboat | 870 | In commission. |
| 37. Practice ship | Gunboat | 835 | Bldg. S. L. M're&S., Eliz., N. J |
| 38. Torpedo cruiser | Gunboat | 750 | Bids to be opened, Feb. 11. |
| 39. *Cushing* | Torpedo Boat | 100 | In commission. |
| 40. Torpedo boat No. 2 | Torpedo Boat | 112 | Bids received, Dec. 20. |
| 41. Dynamite No 2. | Dynamite Gunboat. | 970 | Construction suspended. |
| *Unclassed.* | | | |
| 42. Armored Cruising Monitor | Armored Cruiser | 3,030 | Construction suspended. |

NOTE.—The construction of Dynamite Gunboat No. 2 depends upon the success attained with the *Vesuvius*, and has not yet been ordered. The armored cruising monitor—sometimes referred to as the Thomas monitor—will probably not be built at all.

year, and the guns have been proved and issued to the service. No further contracts of this character will be made with private firms, the capacity of the gun foundry at Washington being sufficient to handle forgings as fast as they will be received.

The ordnance work of the past year has included the completion and installation of the armaments of the *Baltimore*, the *Philadelphia*, the *San Francisco*, and the *Miantonomoh*, while those of the *Newark* and *Concord* are ready.

The 8-in. guns of the *Charleston* are also ready and will replace four of her 6-in. guns on her return. The manufacture of a new armament for the gunnery ship *Lancaster* has been begun. It is believed that with the increased rapidity of delivery of forgings from the Bethlehem and Midvale Companies and the development of the Washington Gun Foundry, batteries can hereafter be furnished to new ships as fast as the latter are completed. The Midvale Company is now engaged in putting up a plant for forgings of large calibers, and by the early part of next year will probably be able to do machining up to 10-in. guns, and to cast and forge up to 13-in. There will, therefore, be two firms in the United States ready to supply any gun forgings that are likely to be needed.

The improvements at the gun foundry during the past year include the erection of the 110-ton overhead traveling crane, the completion of the shrinkage pit, gun carriage shop, and office building, the construction of a siding from the Baltimore & Potomac Railroad, which has greatly facilitated deliveries and shipments, and the purchase of a shifting engine and of several special machine tools.

It is satisfactory to note that with these improvements, both the cost of manufacture and the time required have been largely reduced—in the case of the 6-in. gun from $2,649 and 115 days to $1,298 and 60 days.

Under the act of June 30, 1890, the Navy Department, on September 19 last entered into contract with the Ericsson Coast Defense Company for one submarine gun and six steel projectiles, the gun and projectiles to be fixed and secured in position on board the steam vessel known as the *Destroyer*.

It is proposed to make a thorough test of this system of submarine artillery, which possesses undeniable advantages, if applied to special types of vessels, such as the ram designed for work at close quarters. The experiments will be conducted at the Torpedo Station at Newport.

Cast-iron common shell and shrapnel have been manufactured at Washington and supplied to the new ships as fast as needed. The manufacture of cast-steel common shell has been discontinued for the present, the results obtained not having proved satisfactory. Efforts have been made to develop in this country a process of making common shell of forged steel, as this shell possesses marked advantages, and it is hoped that before long specimens may be obtained for test and that the manufacture may be domesticated in the United States.

The specimens of armor-piercing projectiles hitherto received from private firms in this country, tempered by various processes, have not proved satisfactory, and the only present prospect of securing what we need is by the adoption of some one of the processes in use abroad. A contract has been made for a quantity of projectiles to be manufactured in America by one of these processes, and the Department is still endeavoring to bring about some arrangement by which it may obtain other armor-piercing shells of the best quality of American manufacture.

The great number of inventions, possessing more or less merit, in the way of light rapid-firing guns, has multiplied the number of types in use in all the navies of the world. The manifest disadvantage of this extreme diversity of types, each with its special ammunition, on board a single ship has led the Department to look with favor upon a plan to limit the smaller rapid-firing pieces to the 6-pounder and 1-pounder calibers, and to abandon as fast as is practicable the 3-pounders and the 47-millimeter and 37-millimeter revolving cannon.

The Driggs Ordnance Company has begun work on the ten 6-pounder and the ten 3-pounder guns and ammunition ordered last year.

The Hotchkiss Ordnance Company has filled its original contract with the Department for 94 Hotchkiss guns and ammunition, with the exception of steel shell for the 6-pounder and 3-pounder, in the manufacture of which, of the proper quality, considerable difficulty has been experienced. Deliveries have also been made under later orders.

Owing to delays in the completion of the great armor making plant at Bethlehem, which seem to have been unavoidable, the Department has let contracts for about 6,000 tons of armor, not covered by the contracts with the Bethlehem Company, to Carnegie, Phipps & Company, of Pittsburgh. Deliveries by this company will begin in June next, and by the Bethlehem Company in October.

Further tests are to be made of nickel-steel plates, which are to be very thorough and careful. Until these are completed no extensive purchases of nickel or nickel-steel will be made.

The contract with the Hotchkiss Ordnance Company for torpedoes has not yet been filled. Contracts have been made for a number of Whitehead automobile torpedoes. Some successful tests have been made of the Patrick torpedo.

The Secretary recommends an increase in the number of Rear-Admirals, now insufficient; he also recommends an increase in the number of Commanders and Lieutenant-Commanders, and a decrease in that of Lieutenants, in order to equalize and regulate promotion, and to prevent the exaction of too long terms of service in subordinate grades. A somewhat similar readjustment in the Engineer Corps and an increase in the number of engineers is required.

In conclusion the Secretary again calls attention to the unprotected condition of our sea-coasts, and urges upon Congress the necessity of a fleet of efficient fighting ships to aid in the protection of our harbors and seaport cities. This part of the report is interesting, but space forbids more than the briefest summary here.

The necessity for an efficient Naval Reserve, and the policy of encouraging the formation and training of a naval militia is also dwelt upon at some length.

## THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.

By A. Zdziarski, Engineer.

(*Continued from page 557, Volume LXIV.*)

### II.—THE TRANS-BAIKAL RAILROAD.

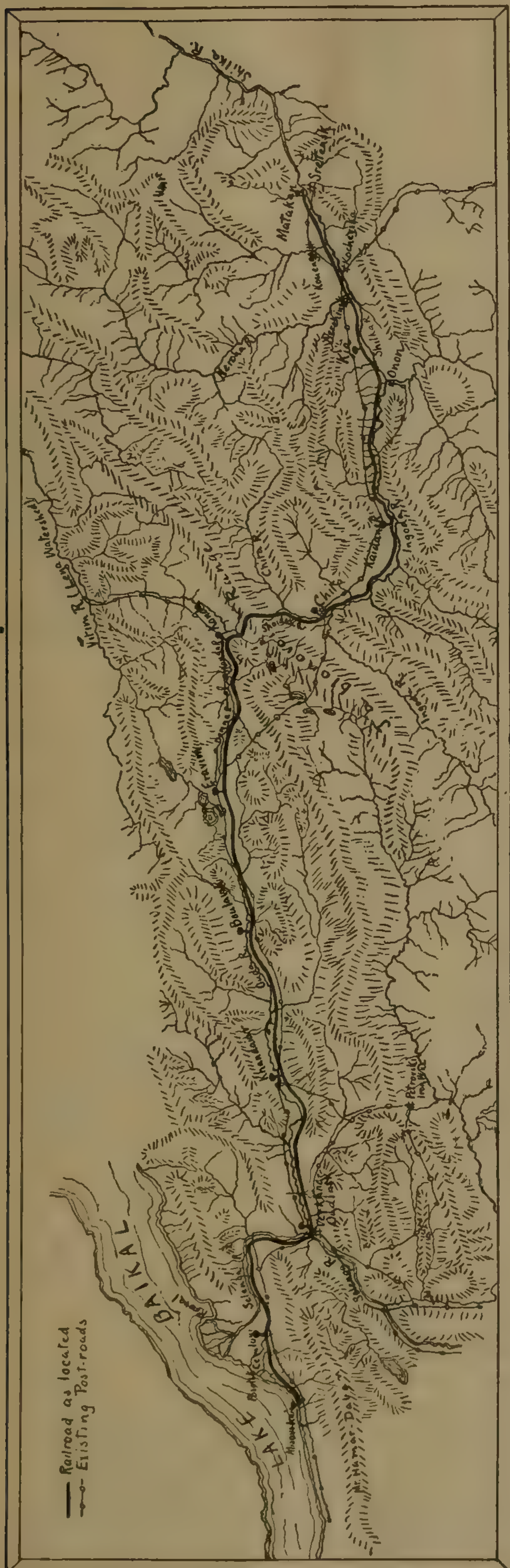
The Trans-Baikal Railroad being intended to connect steam navigation on Lake Baikal with the navigable waters of the Amour River, its starting-point would necessarily be one of the harbors on the eastern shore of Lake Baikal. There are three such harbors, Boïarskaia, Misovskaia and Kluïevskaia; and the explorations made of them having indicated that of Misovskaia as the most suitable, it was adopted as the starting-point of the line.

The eastern terminus of the railroad will be Sretensk, on the Shilka, the principal tributary of the Amour; that river is not suitable for navigation above Sretensk, although it carries a considerable volume of water.

The whole length of the main line from Misovskaia to Sretensk is 663 miles, and branches to the ports or landings on Lake Baikal, the Selenga and Shilka rivers will require 6 miles more, making a total of 669 miles.

The location was not easy, the line having to traverse a heavy mountain country and to cross the Jablonovoï Range. Notwithstanding this, almost the whole line—with an exception of 14 miles only—was located under the conditions of the level sections; that is, with maximum grades of 0.8 per cent. and a minimum radius of curvature of 2,100 ft. Under these circumstances some particulars of the location will be of interest.

From the starting-point at Misovskaia the line follows for some distance the shore of Lake Baikal, then enters the valley of the Selenga River, running between the river and the foot-hills of the neighboring mountain range. Here the direction is northeast, but soon turns southward, still in the Selenga Valley, but crossing many rocky hills and




THE TRANS-BAIKAL SECTION OF THE GREAT SIBERIAN RAILROAD.

passing through the Hamar-Daban Range. At Verkhne-Oudinsk the line crosses the Selenga and turns northeast again, following up the Ouda River nearly to its source.

The further location is governed by the best crossing of the Jablonovoï Range. The descent of those mountains on the eastern side into the valley of the Chita River—which belongs to the Amour system—was the most difficult portion of the line, the height of the pass being 1,120 ft., and the distance in which the descent must be made being short. Thirteen passes, on an extent of 66 miles, were explored by barometric leveling, and the most suitable one found was that of the Shoïdak River, a small stream belonging to the Amour watershed.

Having this in view, the line follows up the Ouda, generally on the side hill, to the mouth of the Pogromma, above which point the valley of the Ouda becomes a rocky gorge, too narrow for the road. It then follows up the valleys of the Pogromma and its tributary, the Kourmuk, reaching a plateau covered with small lakes. Traversing this plateau in a general easterly direction it enters the valley of the Domna, a small river belonging to the Lena system, which is followed until the divide between the headwaters of the Ouda and the Domna is reached and crossed. In ascending this divide it was necessary to put in some zigzags, using radii of 1,750 ft., in order to keep within the limits of grade.

The line then follows the southern or Ouda side of the divide, and on the 330th mile reaches the highest point on the railroad, 3,670 ft. above the sea. This point is the summit of the divide between the Ouda, in the Baikal watershed, and the Tala, a tributary of the Konda, and here the road enters the watershed of the Lena, whose waters flow northward to the Arctic Sea.

Descending the valleys of the Tala and the Konda and ascending that of the Mongoi, the line then rises to the summit of the chosen pass in the great Jablonovoï Range, and finally enters the watershed of the Amour, and descends the eastern slope of the range, following the valley of the Shoidak. The highest point here is on the 400th mile, and is 3,427 ft. above the sea. This point marks the divide between the Lena and the Amour watersheds; that is, between the waters flowing northward to the Arctic and eastward to the Pacific Ocean.

From this divide the line descends the valley of the Shoidak with a continuous grade of 1.2 per cent. to the Chita; from the mouth of the Shoidak it still runs southward, following the Chita River to the town of Chita, the capital of the Trans-Baikal Territory. Thence, turning southeast, it descends the valley of the Ingoda, following the left bank of that stream to the point where it unites with the Onon to form the Shilka River, which, as before stated, is one of the chief tributaries of the Amour.

Entering the flat valley of the Shilka, at first a number of rock cuts and embankments with retaining walls will be needed. Following the left bank of the river, the line crosses the Nercha River not far from the Nerchinsk Iron Works, and reaches its terminus at Matakan, the station there being opposite the town of Sretensk, which is on the right bank of the river, and is the starting-point for steamboat navigation.

Along the whole line only the valley of the Ingoda and that of the Shilka are inhabited; the rest of the country is almost deserted, being peopled only by the half-savage Bouriates, who lead a nomadic, pastoral life.

As above stated, the length of the main line is 663 miles; of this 649 miles come under the conditions of level sections, only 14 miles being mountain sections, with grades of 1.2 per cent., and curves of a minimum radius of 1,400 ft.

In working the line the section containing the mountain passes, from Konda to Chita, 56 miles, will be considered a mountain section, and the trains will be run between those stations with two engines.

For the level sections the maximum grade is 0.8 per cent. and the minimum radius of curvature 2,100 ft., the grade being reduced to 0.75 per cent. where curves of 1,750 ft. radius are used on the zigzags or spirals. For the mountain sections the minimum radius of curvature is 1,400 ft., and the maximum grade 1.2 per cent. This grade, however, is found only in one direction, so that

trains going eastward will encounter no grade over 0.8 per cent.

Under these circumstances on the Chita-Konda, or mountain section, a passenger train of 30 cars will require two engines going westward, but only one going eastward. Freight trains will be handled in the same way; it is expected that the standard freight train will consist of 28 loaded cars in summer, but of 20 only in winter.

The grade is designed for single track only; it will have a standard width of 16.8 ft., the slopes being 1½ or less.

The estimated average quantity of earthwork is about 33,200 cub. yds. per mile; that is, 24,030 cub. yds. of embankment, 3,200 of earth cutting, 1,870 of stone cutting, and 4,100 cub. yds. of rock cutting.

The most difficult earthwork is met with on the shore of Lake Baikal, in crossing the Jablonovoï Range, and on the banks of the Ingoda and the Shilka. The soil is of different descriptions, but generally hard; the stone cuttings will require the use of powder or dynamite. The rocks in the Jablonovoï Mountains are full of water. The subsoil in this country is always frozen, and the cuttings, which at different points reach to a depth of 25 ft. in ordinary soil, 76 ft. in stone and 116 ft. in rock, will be very difficult.

Along the banks of the Ingoda and the Shilka at several points retaining walls will be required. These will be in dry masonry, and the total estimated quantity is 716,000 cub. yds.

The bridges, as designed, will be of different descriptions, as follows:

1. Arch culverts of masonry: 2 each of 7 ft. span.
2. Wooden bridges with masonry abutments: 194 of 7 ft. span and 14 of 14 ft. span.
3. Small wooden bridges: 713 in number, with a total length of 4,991 ft.
4. Small iron bridges: 7 of 20 ft. span; 2 of 35 ft. span, and 1 of 56 ft. span.
5. Large wooden bridges and trestles: 30 in all, as shown in the following table:

| Number. | Length. | Remarks. |
|---|---|---|
| 1 bridge | 35 ft. | Clear span |
| 1 " | 42 " | " |
| 2 bridges | 49 " | " |
| 6 " | 56 " | " |
| 7 " | 70 " | " |
| 3 " | 105 " | " |
| 1 bridge | 126 " | Over Mantourika River. |
| 2 bridges | 140 " | Nikitikha and Baruntala Rivers. |
| 2 " | 210 " | Mongoi and Kia rivers. |
| 1 bridge | 280 " | Talacha River. |
| 1 " | 455 " | Ouroulga River. |
| 1 " | 455 " | Khodoun River approach. |
| 3 bridges | 700 " | Brian, Konda and Chita rivers. |
| Total, 31 bridges | 5,432 ft. | Total length. |

6. Large iron bridges with masonry abutments: 9 in all, as shown in the following table:

| Bridge. | No. of Spans. | Length of Spans. | Total Length. |
|---|---|---|---|
| .................. | 1 | 70 ft. | 70 ft. |
| .................. | 1 | 70 " | 70 " |
| .................. | 1 | 70 " | 70 " |
| Kouenga River | 2 | 245 " | 490 " |
| Krouchina River | 1 | 280 " | 280 " |
| Ouda River | 2 | 245 " | 490 " |
| Khodoun River | 1 | 245 " | 245 " |
| Nercha River | 4 | 210 " | 840 " |
| Selenga River | 13 | 245 " | 3,185 " |
| Total, 9 bridges | 26 | .............. | 5,740 ft. |

The total number of bridges and culverts is thus 973, or 1.45 per mile; their total length, 18,204 ft., or a little over 27 ft. to the mile.

The total quantity of iron required for these bridges will be about 3,000 tons. Masonry foundations will be put in by sinking wells or by the use of wooden caissons of the American type.

The most conspicuous structure on the line will be the Selenga River Bridge, with 13 spans of 245 ft. each. For the pier foundations iron or wooden caissons will be used; in the former case the cost is estimated at 3,150,000 roubles, in the latter at 2,900,000 roubles. In crossing this river a steam ferry may be used in summer and a line laid on the ice in winter; this would diminish the cost by 2,750,000 roubles, but traffic would be interrupted about three months every year.

The total length of sidings will be 7 per cent. of that of the main line, or about 47 miles in all. On the mountain sections the rails used will be of a type weighing 60 Russian pounds (54½ lbs. English) to the yard. On the level sections a lighter rail will be used, of 54 lbs. Russian (49 lbs. English) to the yard. There will be 2,416 ties to the mile, and 2,300 cub yards of ballast to the mile.

The road buildings will be entirely of wood, and will include 163 section-houses and 263 watchmen's houses.

From Misovskaia on Lake Baikal to Matakan (Sretensk) there will be 24 stations, four of the second class, seven of the third class, and 13 of the fourth class. The greatest distance between stations is 35.67 miles. The intervals between stations are divided by means of 19 level places, intended for fifth-class stations; the greatest distance between these is 18.67 miles, while 42 other points were also selected, which when filled will reduce the distance to an average of 10 miles.

In the beginning sidings will be put in only at the regular stations, and these will suffice for running three trains daily each way. If sidings are put in at the fifth-class stations the number of trains can be increased to seven each way.

The station buildings will be of wood, on wooden foundations and with wooden roofs. The houses for the officers and employés will be of the same description. Separate freight stations will be built only at the terminal points and at Verkhne-Oudinsk.

There will be 11 engine-houses with 77 stalls, which will hold two-thirds of the whole number of engines. They will be of wood, with wooden foundations and roofs. The least distance between engine-houses is 40 miles; the greatest, 83 miles, and the average, 66 miles. On the mountain section it is 53 miles.

The repair shops are designed to hold 29 locomotives and 40 cars. The blacksmith shop and foundry will be of masonry with iron roofs; the other buildings entirely of wood.

The arrangements for water supply will be difficult on account of the frozen state of the ground. Water is everywhere, and can be obtained from rivers, lakes or abundant springs, and the height of rise is seldom more than 70 ft.; but the construction of aqueducts or laying of cast-iron pipes is very difficult, because at a certain depth the soil is always frozen. This depth is about 25 ft.; in summer the upper layer, or surface soil, thaws out to a depth of from 2 ft. to 10 ft. Under these circumstances the pipes must be placed very deep, or must be covered in heated galleries; otherwise they must be abandoned, and water pumped from deep wells in the same building with the tank or reservoir.

The plans include 43 water-stations: 11 with pipes placed in heated galleries, 11 with wells, and 21 small stations with temporary supply pumped up by pulsometers. The standard tanks hold 1,372 cub. ft.; two will be placed at each engine-house.

Rolling stock will be provided at first for one mixed and two freight trains daily in each direction. This will require 115 locomotives, 57 passenger cars and 1,140 freight cars.

The cost of the line, 669 miles in length, and without the Selenga Bridge, is estimated at 55,000,000 roubles, or 82,200 roubles (a little over $40,000) per mile.

There is no lack of materials for railroad construction in the Trans-Baikal. Timber is everywhere abundant, including cedar, fir, pine, hemlock and larch; of these the pine and hemlock are best for construction. Stone is also abundant everywhere, and of excellent qualities; there are found on the line granite, diorite, sandstone, lime-

stone, marble, quartz, schist and pudding-stone, or conglomerate. Clay, gravel and sand for ballast are found in many places. Iron for the iron bridges and the rails must be brought from Russia by way of Nicolaevsk, the Amour and the Shilka. Cement must also be brought from Russia; but as some 13,000 tons will be required, and as the materials can be obtained on the line, the construction of cement works would be economy.

While the population of the Trans-Baikal is not large, laborers can be obtained for the building of the road; but it will be necessary to bring from Russia good foremen, and probably all the skilled workmen, carpenters and masons, since very few of the former and none of the latter are to be found there at present.

Masonry can be laid in the open air only for three months of the year—June, July and August. Much of this work will have to be done during the winter, in heated sheds.

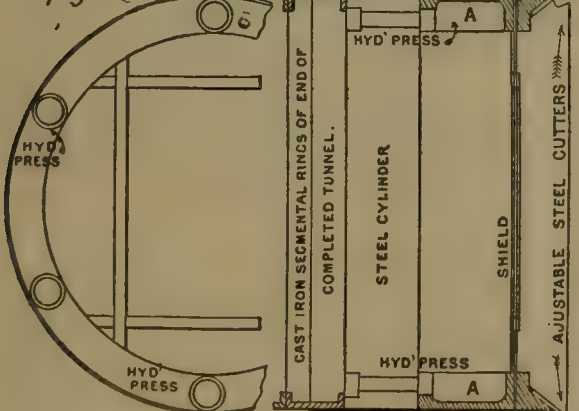
The climate of the Trans-Baikal is continental. The variations in daily temperature are sometimes as much as 30° Cent. (54° Fahr.). The air is dry and the rain-fall small, not over 300 mm. (11.8 in.) yearly. Snow falls very seldom, and scarcely covers the soil. From Verkhne-Oudinsk eastward sleighing on the roads is rare, and sledges are used only on the rivers, following the ice. There are only three months of the year in Verkhne-Oudinsk when the daily minimum temperature is not above the freezing point. For three years past the maximum temperature noted is 37.2° Cent. (98° Fahr.); the minimum,—46.6° Cent. (—51.9° Fahr.). In a word, the climate is that of an elevated plateau, open to the winds from the north, and remote from the tempering influences of the sea.

(TO BE CONTINUED.)

## THE LONDON ELECTRICAL RAILROAD.

The City & South London Railroad, just opened in London, is remarkable from the fact that it is the first considerable line in England worked by electricity, and also because it is placed at a much greater depth below the surface than the other underground lines in that city. It is about three miles in length, extending from the heart of the city southward.

In the accompanying illustrations fig. 1 shows the shield used in boring the tunnel—which is somewhat similar to that used in the Hudson River Tunnel—on the Greathead plan; fig. 2 shows the interior of a car; fig. 3 is an in-




terior view of one of the stations; fig. 4 is an elevation, and fig. 5 a section of one of the locomotives: figs. 6, 7 and 8 show three of the stations, which are of peculiar and striking design. All the stations have hydraulic elevators to carry passengers to and from the platforms. The description is from the London *Electrician.*

The railroad is of the subway type, passing from King William-Street, in the City, under the Thames, to Stockwell. The line has been constructed on a method designed by Mr. Greathead, in the form of two circular iron tunnels 10 ft. in diameter, driven throughout the London clay, and about 60 ft. below the surface. The method of working resembles the sinking of a caisson. A steel shield was forced forward while material was excavated. When a sufficient advance had been made, a ring of cast-iron plates was built up, and a lime grout was forced into the space left by the sides of the shield between the lining plates and the soil. A speed of 16 ft. per day was attained, and since the tunnels were commenced several other im-

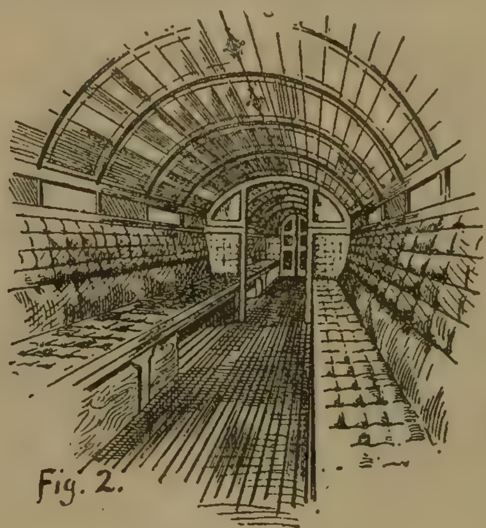
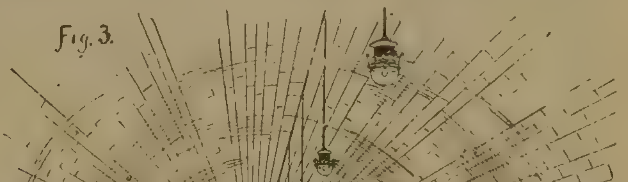


Fig. 2.

portant works have been constructed, or are in progress, on the same plan. Near the Stockwell terminus an old watercourse, consisting of gravel, with a considerable quantity of water, was encountered. The air-lock principle, for which this system is excellently adapted, was employed, and after some delay in providing the necessary machinery, which it was hoped might have been unnecessary, the tunnels were satisfactorily completed. It was originally intended to work the railroad by cable, but tenders were invited for running it by electricity, and eventually plans were submitted to the Company by Messrs. Mather & Platt, and the Company accepted this firm's

Fig. 3.



scheme, which is based upon the experience obtained by Dr. Edward Hopkinson, in the construction of the Bessbrook-Newry Electrical Railroad. The contractors employed Messrs. John Fowler & Company, of Leeds, to supply the boilers and engines, and Messrs. Beyer, Peacock & Company to construct the framework of the electrical locomotives. All the electrical plant has been carried out under the special superintendence of Dr. Edward Hopkinson. Dr. John Hopkinson has acted throughout as Consulting Engineer, and Mr. G. A. Grindle as Resident Engineer.

The whole of the generating plant is situated at Stockwell, the suburban terminus of the line. It consists of three large Edison-Hopkinson dynamos, each worked independently by a vertical compound Fowler engine. The engines work at a steam pressure of 140 lbs. per square inch, and have been built of exceptionally massive proportions. They run at 100 revolutions, giving a piston speed of 450 ft. per minute. They are fitted with automatic expansion gear of improved type on both the high-pressure

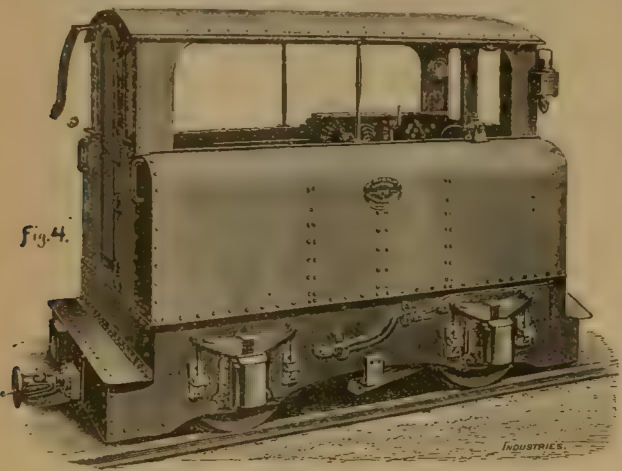


Fig. 4.

and the low-pressure cylinders, and are controlled by a powerful governor having a capacity of 750 foot-pounds, which is driven direct from the crank-shaft by cotton ropes. The automatic gear is so arranged as to cut off the steam, if necessary, in both cylinders from dead cut-off to three-quarters stroke. The engines have high-pressure cylinders 17 in. in diameter and low-pressure cylinders 27 in., the stroke being 27 in.; they indicate up to 375 H. P. each. The pistons are fitted with Mather & Platt's rings and springs, and the valves are specially arranged with multiple parts which reduces their movement considerably and still allows a very prompt action; as the ports are as close as possible to the end of each cylinder, the loss of pressure by wire drawing is very small. Large and slow-speed engines were selected on account of the very irregular nature of the work, it being considered that the high-speed engines which are so largely and economically used for electric lighting could not so well cope with the sudden variations of load as the type which has been selected. The fly wheels are 14 ft. diameter and 28 in. face, and drive the dynamos direct by means of leather chain belts 26 in. wide.

It is a pity that the engine-room does not permit of a greater distance than 24 ft. between the centers of the en-

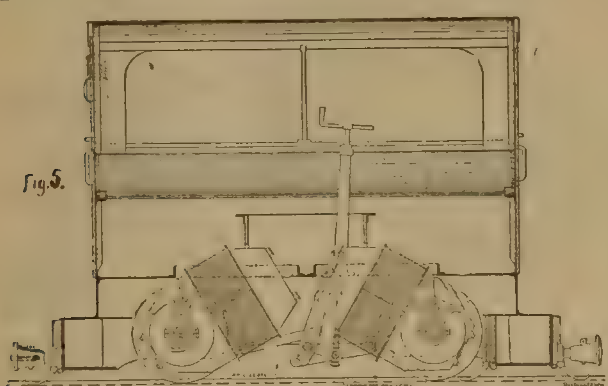


Fig. 5.

gines and that of the dynamos, since jockey pulleys are rendered necessary. These are all very well as an expedient, but are not often to be met with in an important station of this kind. The engines are supplied with steam from six Lancashire boilers 7 ft. diameter by 28 ft. long, which are fitted with Vicar's mechanical stokers.

Livet's boiler setting is used, which provides flues of a varying area, and which, in conjunction with the mechanical stoker, is said to effect a saving of fuel, and certainly succeeded on the occasion of our visits to the depot in preventing smoke. Two large feed-water heaters are also supplied with brass tubes of ample surface for receiving the whole of the exhaust steam from the engine without back pressure.

The 202-kilowatt dynamos are fitted with all the latest improvements; the weight of the armature alone, which is drum wound with spiral ends, being about two tons, the weight of the entire machine being something over 17 tons. Each machine is capable of generating 450 volts and 450 amperes. There are three brushes on each rocking arm, each separately adjustable with a forward thrust and hold-off catch. The magnet limbs are exceedingly massive, each limb with its pole piece being over four tons, and the yoke of the machine weighs about three tons. The machines can be run either as shunt or compound as required. The total weight of copper wire on the magnet of each machine is nearly 3,300 lbs. The present machines have an electrical efficiency of slightly over 96 per cent., and the commercial efficiency of the engine and dynamo —*i.e.*, ratio of the electric power available outside the dynamo to the indicated H. P. of the engine, is over 75 per cent. Two dynamos are capable of working the trains on the line at any time.

The current is conveyed from the dynamos to a general distributing and testing switch-board, fixed in a recess of the engine-house. From this board, which resembles in some respects the Westinghouse switch-board, which is very well known, the main circuits are taken to various parts of the line, and the current passing through each cir-


Fig. 6.

cuit is measured, suitable arrangements being provided for switching over from one circuit to another. The main cables have been manufactured by the Fowler-Waring Company, and consist of a copper core of $\frac{61}{14}$ B. W. G., insulated with Fowler-Waring insulating material and then lead-sheathed.

The working conductor is of channel steel carried on glass insulators, the joints being fished, and also connected with copper strips. The steel employed is of very high conductivity, and has been rolled specially for the purpose by the Shelton Iron & Steel Company, of Stoke-on-Trent. The working conductor is divided into sections for convenience of testing and carrying out repairs on the permanent way. The insulation obtained is thought by the contractors to be extraordinarily high. When the full pressure of 500 volts is on the complete system of working and feeding conductors, the leakage current does not exceed one ampere, so that the total loss by leakage is less than 1 H. P.; this is a small fraction of 1 per cent. of the total power required for working the line to its full capacity. The current is collected from the working conductor by sliding shoes of iron or steel arranged in a very similar way to that employed on the Bessbrook line.

Fourteen electric locomotives have been supplied by Messrs. Mather & Platt for working the line, each capable

of developing 100 effective H. P., and of running at about 25 miles per hour. The locomotives are constructed so that the shafts of the armatures are the axles of the locomotives. The driving wheels run at about 240 revolutions per minute when the locomotive is travelling at 20 miles per hour. The locomotives have a fixed wheel-base, and

Fig. 7

a motor is fitted to each axle, the axles not being coupled, but working independently. The current is conveyed from the collecting shoes through an ammeter to a regulating switch, then to a reversing switch, thence to the magnets and back through the frame-work of the locomotive to the rails. The locomotives are fitted with Westinghouse automatic air brakes, and also a screw hand-brake, and they

Fig. 8.

and the carriages are lighted from the working conductor by lamps in series. The compressed air for the brakes is stored in two cylinders, 12 in. in diameter, and the capacity is sufficient for three times as many stoppages as are likely to occur in any double journey. The trains, when loaded, will weight 30 tons, and it is intended that 10 trains shall be worked on the line at one time.

## FLYING MACHINES.

MR. HIRAM S. MAXIM, in a letter published recently in the New York *Times*, writes as follows :

I would say that I have been studying this question about 18 years, principally in the direction of finding some powerful and light motor, but during the last two years I have been employing myself largely evenings to working out the mathematical part of the problem. I have obtained all the data in German, French and English. I have also examined the experimental apparatus in France, but am sorry to say that all the data and information so far obtained are of very little value. A single letter written by Professor Richard A. Proctor, and which was published in a Boston newspaper, furnished more real information than tons of the work which has been published in Europe. Some 25 years ago a society was formed in England styled the Aeronautical Society of Great Britain. The patrons of this society were the Duke of Argyll and the Duke of Sutherland, and the society also numbers among its members many other noblemen and engineers of high repute. I believe there are 19 different volumes in existence which give an account of all their procedures and experiments, but during all these years very little practical work has been done.

I would say that among the large numbers of societies to which I belong in England the Aeronautical Society is one, and need I say that I am the most active member? At the present moment experiments are being conducted by me at Baldwin's Park, Bexley, Kent, England, with a view of finding out exactly what the supporting power of a plane is when driven through the air at a slight angle from the horizontal. For this purpose I constructed a very elaborate apparatus, provided with a great number of instruments, and arranged in such a manner that I can ascertain accurately the efficiency of a screw working in air, the amount of power required to drive a screw, the amount of push developed by a screw, the amount of slip, and also the power required for propelling planes through the air placed at different angles, as well as to ascertain the friction and all other phenomena connected with the subject. I have been experimenting with motors, and have succeeded in making them so that they will develop one horse-power for every 6 lbs. My experiments show that as much as 133 lbs. may be sustained in the air by the expenditure of one horse-power; of course, it is premature now to express any opinion; still, if I am not very much mistaken, and if some new phenomenon which I do not understand does not prevent it, I think I stand a fair chance of solving the problem, and I think I can assert that within a very few years some one—if not myself, somebody else—will have made a machine which can be guided through the air, will travel with considerable velocity, and will be sufficiently under control to be used for military purposes. I have found in my experiments that it is necessary to have a speed of at least 30 miles per hour—that 50 miles is still more favorable, and that 100 miles would seem to be attainable. Everything seems to be in favor of high speed. Whether I succeed or not, the results of my experiments will be published, and as I am the only man who has ever tried the experiments in a thorough manner with delicate and accurate apparatus, the data which I shall be able to furnish will be of much greater value to experimenters hereafter than all that has ever been published before.

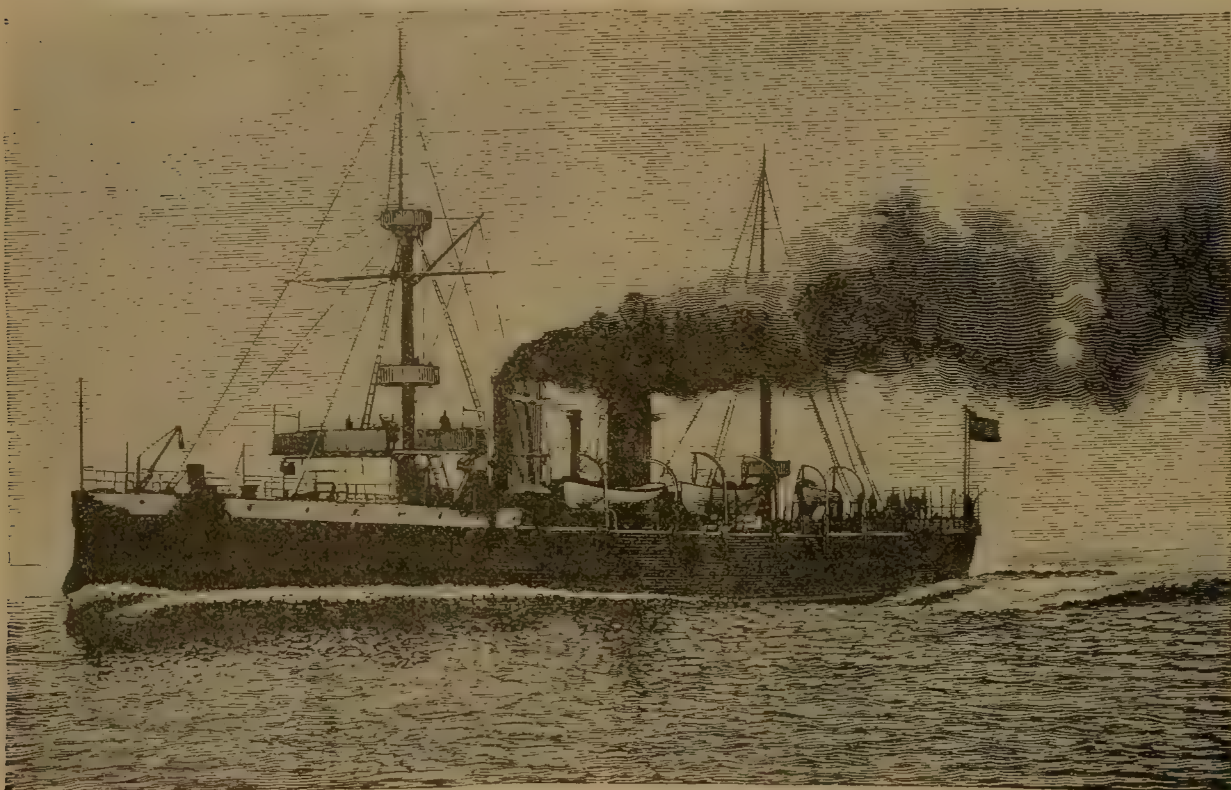
In order to conduct these experiments I rented a large park—in fact, an old manor—and erected a wooden shed of large dimensions. I provided myself with every requisite and employed two eminent American mechanics to assist me—Mr. Henry A. House and Mr. Henry A. House, Jr., both of Bridgeport, Conn. These gentlemen have already been working with me more than a year, and both seem very confident of our ultimate success.

I appreciate fully the presumption on my own part of attempting to solve this problem, considering that all mankind have failed up to this time. Nevertheless, it is a fact that we do see in nature machines which do fly, some birds weighing nearly 50 lbs. each; even a common goose can fly without any considerable effort. It is true that no one has ever taken hold of the question in the same way and with the same appliances that I have. Most of the experiments have been confined to small machines weighing only a few ounces and having for a motor a twisted rubber string or spiral spring. If an experimenter has had the necessary intelligence and mathematical knowledge, he has not had the necessary room or money to conduct his experiments, and the results so far have been nil, but I feel satisfied that if such men as Mr. Westinghouse,

Mr. Charles Brush, and Mr. Edison should seriously and earnestly attempt to solve the question they would succeed in making some sort of machine that would fly, but they would have to do as I have done—obtain a place where there would be plenty of room, provide themselves with the very best of mechanics, and spend about $50,000. I would say that the two motors which I have made, and which weigh 600 lbs., cost their weight in silver, while an engine of very much less power, made by a French experimenter, cost more than three times its weight in silver.

## THE FASTEST CRUISER.

It is hardly safe to speak now of the "fastest cruiser," when each new one seems to excel its immediate predecessor. The new ship, *25 de Maio*, built for the Argentine Republic by Armstrong & Company at their works at Elswick, England, seems for the present to hold the record for speed. This vessel is shown in the accompanying illustration—for which and the description we are indebted to the London *Engineer*—which was drawn from an instantaneous photograph taken when the ship was running at the rate of 21½ knots an hour.



CRUISER "25 DE MAIO," FOR THE ARGENTINE NAVY.

The steam trials of the *25 de Maio*, which have just been completed, mark a distinct step in the speed attained by fast cruisers. This vessel, which is of the twin-screw protected cruiser type, has been constructed by Sir W. G. Armstrong, Mitchell & Company for the Argentine Government, which may well be congratulated on the acquisition of such a splendid specimen of naval engineering. She is somewhat larger than the *Piemonte*, which was built by the Elswick firm for the Italian Government, and which, as our readers will remember, on her completion about 18 months ago, herself broke the speed record. The dimensions of the *25 de Maio* are as follows: Length between perpendiculars, 325 ft.; breadth, 43 ft.; mean draft, 16 ft.; displacement, 3,200 tons.

The machinery and vital parts of the ship are protected by a strong steel deck extending throughout the whole length of the ship, such as is usually adopted in this class of vessel, but of unusual strength, being 4½ in. thick on the sloping sides and 1¾ in. thick on the horizontal portions. Above this deck is constructed a deep raft body divided into numerous watertight compartments, which may, if desired, be filled with cork or other water-excluding material, thus insuring buoyancy to the ship even if riddled in action.

The vessel is armed largely with the formidable rapid-firing guns recently introduced by the Elswick firm, arranged to have the largest effective arc of training. On the forecastle, firing right ahead and to 45° abaft the beam on each side, is a 21-cm. (8.27-in.) breech-loading gun. A similar gun is mounted on the poop firing right astern, and with an arc of training equal to that of the forecastle gun. On the upper deck in sponsons along the sides are arranged eight 12-cm. (4.72-in.) rapid-firing guns, the foremost pair being capable of firing right ahead to 45° abaft the beam, the two aftermost having a corresponding stern fire, and the four midship guns an arc of training of 120° broadside fire.

The minor armament has also been well considered, and consists of twelve 3-pounder rapid-firing guns and twelve 1-pounder rapid-firing guns, distributed in the most effective manner, six of the 1-pounders being mounted in military tops on the two masts.

The modern locomotive torpedo has not been overlooked, for the vessel is provided with three 18-in. torpedo guns, two of them training on the broadside and one fixed in the bow. The machinery was constructed by Messrs. Humphrys, Tennant & Company, of London, and consists of two sets of four-cylinder triple-expansion engines and four double-ended boilers, each set of engines and each pair of boilers being placed in separate compartments.

The steam trials, which have just taken place on the Admiralty measured mile off the mouth of the Tyne, were attended by a Commission of Argentine Officers, including Captain Spurr, Captain Garcia, Captain Ramirez—commander of the vessel—and Colonel Warren on behalf of the Argentine Government; Mr. P. Watts, designer of the vessel, on behalf of the Elswick firm; and Mr. Robert Humphrys representing the constructors of the machinery.

At the official trials a run of six hours' duration was made with natural draft, in accordance with Admiralty conditions; and, while this trial proceeded, a number of runs with and against the tide were made on the Admiralty measured mile, the results of which demonstrated that a speed of 21.237 knots per hour had been maintained during the whole six hours' run. During this trial the mean power developed was 8,700 indicated H. P. At the forced draft trial, which was made at the close of the day, when the fires were in bad condition and the stokers tired, the mean speed attained was 22.43 knots per hour, and the mean power 13,800 indicated-horses. Throughout the day the engines worked in a most satisfactory manner, without a hitch of any kind, and the Argentine Commission were highly delighted with the performance of the ship.

The vessel carries 300 tons as her normal supply of coals, but bunker capacity is provided for 600 tons. With the full supply of coal she could steam about 2,000 knots at full speed, natural draft; while, at the most economical speed, she could steam from 9,000 to 10,000 knots.

## THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.



(*Continued from page* 562, *Volume LXIV.*)

### IV.—GENERAL CONSIDERATIONS.

Unquestionably the submarine mine has, in the eyes of the military layman, if one may use the term, an exaggerated and fictitious value. While the view that it will practically replace all other means of coast defense is no longer held by the most sanguine, still even among military men it is believed to be given too prominent a place in the problem of sea-coast defense. Such a misunderstanding as to their true value would be of little importance, as a matter of popular belief, except as it might have an influence upon national legislation and be felt in the question of appropriations. But an erroneous opinion among professional military men—artillerists and engineers—into whose hands are confided the defense of port and harbor, means an entirely different thing. If in placing too much reliance upon the mine, at the expense of the battery and gun, we are leaning upon a broken reed, such misplaced confidence can only lead to the most deplorable results if we are ever called upon to face a powerful maritime foe.

There is by no means a unanimity of view among these two classes of military men as to the extent and conditions under which mines should be used, or the ultimate reliance to be placed upon them when employed. In any case they can only become one of the factors in the problem of defense, and their employment must be brought into harmonious relations to the general plan.

To properly plan and carry out a system of submarine mines for the defense of a harbor or water-way is a problem that demands the intelligent co-operation of the artillerist and the military engineer. The conditions to be satisfied pertain not only to matters that belong properly to the domain of the engineer—the character of the channel to be guarded, its depth, width, and nature of its bottom, the swiftness of its current and the rise and fall of its tides—but also to the configuration of the land, the location and strength of the shore batteries, their range, the volume, and maximum field of their fire.

The first question to be decided is the extent to which mining shall be resorted to in closing a water-way—that is, the number, size, and distribution of the individual mines. If the channel be narrow and the artillery defense of the first order, less attention would be given to mine defense than if the contrary conditions prevailed, having in mind always the importance of the position to be protected, either as a point of vantage for military operations, or for the levying of contributions or the destruction of property. It may be taken for granted that, with few exceptions, the importance of a seaport, either from a military or commercial point of view, will vary directly with the draft of water and consequently with the tonnage of the shipping that can be carried to its wharves.

If the channel be narrow and deep the solution becomes comparatively simple. The mines, however few in number, should be distributed upon more than one line to guard against the opening of a passage by the destruction of a single charge. In any case, the general rule will hold that whether the mines be arranged singly or in groups, the individual mines shall be so placed that it will be impossible for a vessel to pass without coming within the destructive area of one or more of them; guarding always against the possibility of a premature explosion of any one of a system by the shock of explosion of an adjacent mine.

Whether the mines shall be buoyant or ground will depend both upon the depth of water and the character of the bottom. In water of moderate depth and a bottom not too soft a ground mine is to be preferred, since it serves as its own anchor, cannot get adrift, is not easily exploded by an adjacent charge, and is more difficult for an enemy to destroy or neutralize. A buoyant mine, on the other hand, requires a large excess of buoyancy, so that it will remain as nearly stationary as possible over its mooring, to secure which a case must be provided much larger than will hold the required charge. This buoyancy must be increased with the swiftness of the current, so that in strong tideways a buoyant mine is a difficult thing to manage. There is also always a possibility of their breaking from their moorings and going adrift, and thus become a menace to friend quite as much as to foe.

A depth of water of more than 35 or 40 ft. will preclude the use of ground mines, and except in shallow water a buoyant mine would be anchored so as to swing from 10 to 40 ft. below ordinary high-water mark; the distance depending, of course, upon the depth of the channel, the rise and fall of the tide, the size of the mine, and the class of vessel against which it is likely to be used. A first-class iron-clad will draw from 25 to 30 ft. of water, while the smallest war-ship likely to be sent across sea for offensive operations would probably range in draft as low as 10 or 12 ft. The English *Benbow* has a draft of over 28 ft. Some of the earlier built English armored gunboats draw less than 12 ft., and their torpedo vessels of the *Rattlesnake* and *Sharpshooter* type less than 9 ft. The heaviest of the French armored fleet have a draft of nearly 30 ft., while the Italian *Lepanto* and her sister ship, the *Italia*, require 31.2 ft. to float them. Generally speaking, a harbor provided with a good artillery defense would not require the assistance of a system of mines against vessels drawing less than 18 or 20 ft. of water

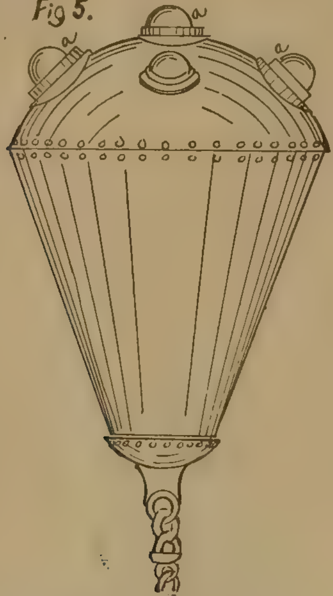
Next to the arrangement of the system comes the question of material, and of the cases in which the explosive is to be placed. These latter must have sufficient strength to resist the pressure of the water and to stand rough handling; they must be absolutely water-tight, although the latter is of less importance if the explosive be gun-cotton or dynamite than if of gunpowder, except as leakage interferes with buoyancy; if for a buoyant mine, the case to be of as light material as the other conditions will admit of. In a gunpowder mine the case should be relatively stronger than in one containing a high explosive, in order to hold the charge together for an instant after ignition, so as to obtain its maximum explosive effect.

The shape of the mine case is not a matter of vital importance. For contact mines the conical or cylindrical form is that usually adopted. For ground mines the English employ hemispherical or dome-shaped cases of cast iron, the flat side resting upon the bottom forming its own anchor. For their buoyant mines they use two or three different patterns of spherical cases, made up of two flanged hemispheres of steel, wrought iron or malleable cast iron, bolted together at the flanges, and packed at the joint with rubber or other like material, or riveted to a narrow metal plate on the inside. This shape is now recognized as the best for a buoyant mine. In their earlier system they used an inner case of thin wrought-iron plate, and to protect this case and provide the necessary buoyancy, enclosed it in a wooden jacket of considerable thick-

ness. It has been found from experiment that the enclosing of the mine case in wood, cork, or other elastic material results in a considerable loss of power.

In our own service buoyant mine cases are constructed of two hemispheres of thin steel, welded together at the

Fig 5.



flanges. For ground mines the turtle-back or mushroom shape is recommended.

An air space that much exceeds in volume three times that of the charge has been found to produce considerable diminution of explosive effect. In all cases the size of the envelope should be kept down to the lowest dimensions compatible with the work required of it.

### V.—AUTOMATIC MINES.

Notwithstanding the grave objections that can be urged against the automatic or self-acting mine, from the fact that it will act alike against friend and foe, there are times when, in planning for the defense of a harbor, its use becomes judicious.

If called upon to defend a wide water area, or shallow channels not likely to be used by friendly vessels in war time, these could well be closed with automatic mines; or if called upon to improvise a scheme of mine defense without the time or material necessary for the preparation

Fig. 6.

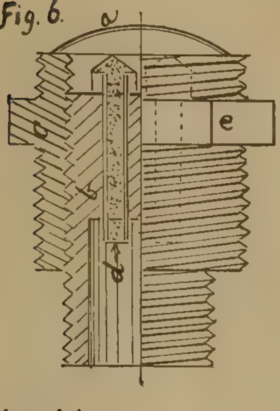
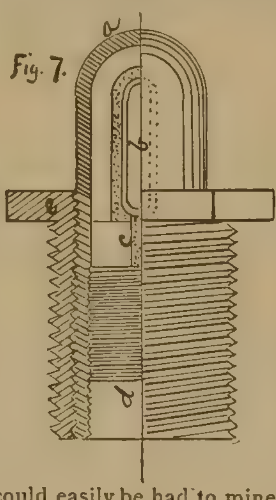


Fig. 7.



of an elaborate system, resort could easily be had to mines of this class.

An automatic mine should, General Abbott says, fulfil three conditions: "(1) That no safety arrangement which requires the act of the planting party to remove is admissible; (2) that some arrangement to cause the immediate explosion of the charge if the mine gets adrift is essential; (3) that every possible means should be taken to make their removal difficult." He adds that upon the latter point there is a wide difference of opinion among engineers.

The Confederates, with no navy to take the sea, with no commerce to be interfered with, if we except the few light draft blockade-runners, could well afford to blockade the entire harbor area of their coast with this class of mines. Some of those devised or improved upon by them remain as types of the best.

The *Automatic Mechanical Mine* was a favorite type with the Confederates. Fig. 5 represents one of the best of this class, the Brooke mine. The case is of metal, conical in shape, and had upon its hemispherical top five fuses. Two varieties of fuses were used with this mine. One, known as the Rains fuse, is shown in fig. 6, half in elevation and half in vertical section. It consisted of an outer cylinder *c*, provided with a thread on its outer circumference for screwing into the mine case; an inner cylinder *b*, carrying the primers *d*, which could be screwed up until the heads of the primers came in contact with the copper cap *a*. The detonating compound was a mixture of fulminate of mercury and ground glass. The hexagonal projection *e* serves for applying a spanner to screw it into the case. The other, shown in fig. 7—the Jacobi chemical fuse—consists of an outer cylinder *e* and an inner one carrying a lead safety-cap. Within this cap was a hermetically sealed glass tube *b*, filled with sulphuric acid, surrounded with a mixture of chlorate of potash and white sugar; *c* is a primer of mealed powder leading to the interior of the mine case. A bending of the lead cap, as

Fig. 8.

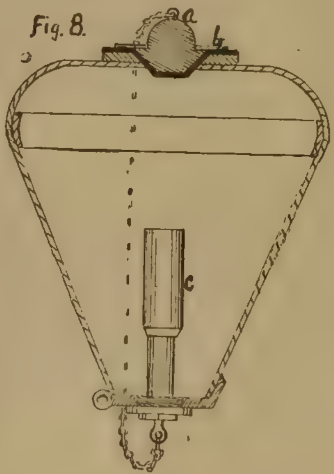
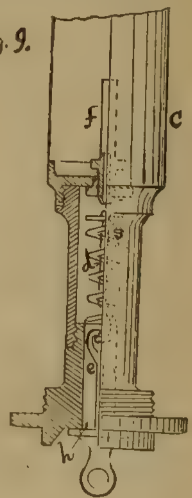


Fig. 9.



from the blow of a passing vessel, breaks the glass tube, when the action of the acid upon the surrounding mixture develops sufficient heat to ignite the mealed powder and so fire the mine.

Another form of the automatic mine is that known as the Singer. In this mine the blow of a colliding vessel displaced an iron cap resting upon the top of its sheet-iron case. This in falling released, by means of a cord or wire, a plunger, which, under the action of a spiral spring, was forced against the fulminating mixture and fired the mine. The McEvoy improved form of this mine is shown in section in fig. 8. The weight *a* rests in a seat upon the top of the case, held temporarily in place by a papier-maché cover *b*, screwed down to the seat. A short submersion in water softens this material and the mine becomes active. The blow from a vessel dislodges this weight, which falling operates the firing mechanism contained in the tube *c*, screwed into the base of the case.

This firing mechanism is shown in elevation and section in fig. 9. Under the action of the falling weight the hook *e* is drawn down, carrying with it the striker *d*, compressing at the same time the spiral spring *s*. As soon as the hook clears the passage *h* the striker is released, flies upward, and in impinging upon the cap of the fuse *f* fires the mine.

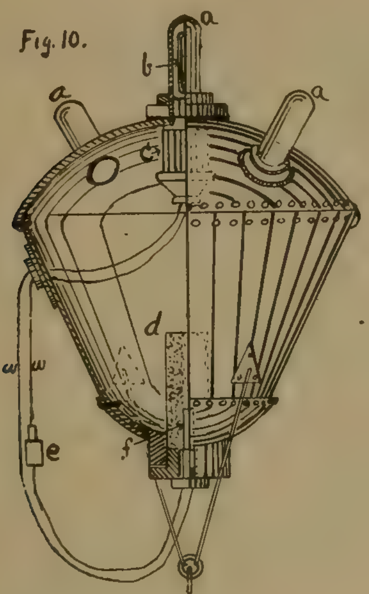
In the Mathieson mine a cylindrical tube is screwed into

a seat on the top of the mine case, containing the firing mechanism. A plunger, weighted with mercury, is suspended at the top of the tube by a vulcanite stem. A powerful blow serves to break this stem when the plunger falls upon a percussion cap, igniting a priming charge, and through it the mine. A disk of zinc confines the mercury to a safety chamber for some hours, long enough for the mine to be planted. The zinc disk is finally eaten away, the mercury descends into the plunger, and the mine becomes active.

The *Automatic Electrical Mine*, as its name indicates, employs an electrical current for igniting the explosive charge, instead of depending upon mechanical means for that purpose, as in the mines just described. A small battery and an electrolyte are provided, so situated that the shock of a colliding vessel brings the electrolyte in contact with the battery, generating a current, and by means of an electrical fuse firing the charge. This mechanism is usually within the mine itself, but may be in a buoy above the mine, or within its anchor.

Fig. 10 shows a Hertz mine with its firing arrangement, half in section and half in elevation. Each of the projecting lead tubes, *a*, of which there are five, contains a chlorate of potash mixture enclosed in a glass tube. Beneath is a brass case containing several pairs of carbon and zinc

Fig. 10.




plates, forming a cell *c*. Two insulated wires, *w*, lead into the case, one connected with the zinc terminals of the five cells, the other with the five carbon terminals. The other extremities of these wires are connected with the electrical fuse *f*, embedded in the priming charge *d*. The crushing of the glass tubes precipitates its contents into the cell beneath, excites a current and ignites the fuse. As a means of safety the lead tubes are, until the mine is planted, covered with brass cylinders, and one of the wires is provided with a key *e*, which is closed when the mine is to be rendered active.

In the McEvoy mine a weight is dislodged, as in the Singer type of mine, which breaks the glass tube containing an electrolyte, and the action is the same as in the case just described. In the English naval mine two small Leclanché cells are enclosed within the mine, their terminals leading through a circuit-closer to an electrical fuse. This circuit-closer consists of a metal cup partly filled with mercury. One wire is in contact with the mercury, the other with a stem projecting into the cup and a short distance from the surface of the mercury. A violent blow throws up the mercury, closes the circuit, and ignites the fuse.

(TO BE CONTINUED.)

## THE NEW YORK AND NEW JERSEY BRIDGE.

At a meeting of the Commissioners of the New York & New Jersey Bridge held December 2, a report was presented on the proposed structure. The plans for the bridge cannot be completed until the War Department gives its decision fixing the height and length of span for the bridge, as it is required to do under the act authorizing the bridging of the Hudson River. The location adopted by the Commissioners is given in the report as follows:

Beginning at a point in New Jersey on the west side of the Hudson River, between the lines of Seventieth and Seventy-first streets, in the city of New York, produced; thence running easterly between Seventieth and Seventy-first streets to a point near Eleventh Avenue; thence curving to the south and running about 100 ft. west of the west line of Eleventh Avenue to such a point as far north of Thirty-eighth Street as will allow of a curve of proper radius; thence curving to the east and running between Thirty-eighth and Thirty-ninth streets to a union station, which union station will cover the blocks between Thirty-seventh and Thirty-ninth streets, and extend from Eighth Avenue to Broadway.

One approach to extend from said union station in diagonal line to a connection with and for the Manhattan Elevated Railroad on Sixth Avenue at or near Thirty-third Street.

Another approach will run from the west end of the said Union Station at Eighth Avenue with a two-track line descending toward the Hudson River in the lower part of the viaduct above the New York Central & Hudson River Railroad tracks lying between Sixtieth and Seventy-second streets, and will descend to a level of about 8 ft. above the mean high tide in the Hudson River at or near Seventy-ninth Street. Thence it will run along the river front outside of the present New York Central & Hudson River Railroad tracks upon a pile foundation, or filling, or both, to be made for it. Near One Hundred and Fifty-fifth Street it will rise over the New York Central & Hudson River Railroad tracks and curve to the east into a tunnel about half a mile long at or near One Hundred and Fifty-fifth Street, coming out on the east side of the hill and crossing at a clear elevation of 18 ft. above the tracks of the Manhattan Elevated Railroad at or near One Hundred and Fifty-fifth Street; thence across the Harlem River in a northeasterly direction to a connection with and for the New York & Northern and the New York Central & Hudson River railroads, opposite or nearly opposite One Hundred and Sixty-second Street prolonged. Thence substantially by a direct line to a connection with and for the New York & Harlem Railroad, at or near One Hundred and Sixty-second Street. Thence along the easterly side of the Spuyten Duyvil & Port Morris Railroad to Long Island Sound, and to a connection with and for the Harlem River & Portchester Branch of the New York, New Haven & Hartford Railroad. Connections will be made with all intersecting railroads. Stations to be erected at all connections with railroads, and also at or near Seventy-second Street, Eighty-sixth Street, Manhattan Street, and One Hundred and Fifty-fifth Street.

## THE HUDSON RIVER IMPROVEMENT.

An examination is now being made of the channel of the upper Hudson, with a view to estimating the cost of deepening it, so as to enable vessels drawing 20 ft. of water to go up the river to Albany and Troy. At present there is deep water in the Hudson as far as Coxsackie, about 120 miles from New York. From that point to Albany the channel is narrow and crooked, but considerable sums of money have been spent upon it from time to time, both by the State of New York and the United States. The existing channel, which is maintained by dikes and by frequent dredging, is 11 ft. in depth and 175 ft. in width from Coxsackie to Albany, about 28 miles. From Albany to Troy, 5 miles further, it is 10 ft. in depth and 140 ft. in width. The deepening of the channel to 20 ft. will require

the removal of several bars with a good deal of diking, and possibly the cutting of an entirely new channel at one or two points, but will be of great benefit to navigation.

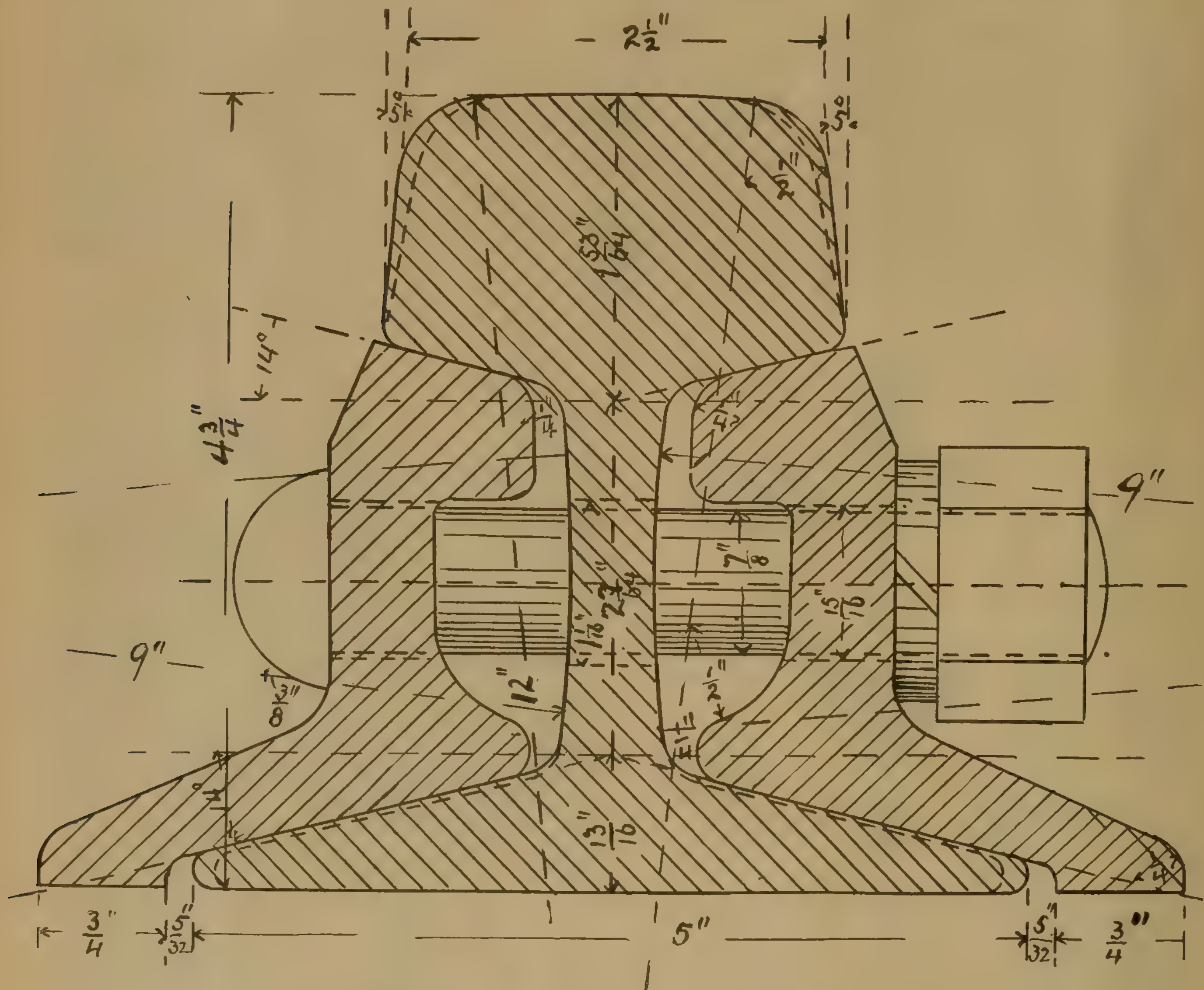
Perhaps the widening of the channel would be more beneficial than an increase in depth. The number of tows coming from the canal at Albany is very large, and in the present condition of the river there are several points where passing two such tows is not an easy matter. Much injury is done to the channel by heavy ice in the winter and spring, which damages and sometimes breaks through the dikes, and aids in forming bars and obstructions.

## THE LEHIGH VALLEY STANDARD 80-LBS. RAIL.

THE accompanying illustration shows a section of the 80-lbs. steel rail recently adopted as a standard by the Lehigh Valley Railroad Company. It replaces a 76-lbs. rail, the section of which is shown by the dotted lines which come inside the full lines showing the new section. It will be seen that the additional metal has been placed partly in the head, increasing its width somewhat, and partly in the foot of the rail, which is slightly wider in the new than in the old section. The corners of the head, it will be seen, have one-half inch radius, as heretofore, while the metal in the stem has not been increased.

The same joint is used for the new as for the old section. This Company has for two years past adopted the plan of cutting the ends of the rails miter, or at an angle of 45°, and this plan has worked so well that there is no disposition to abandon it. The advantages found are in the absence of jar at the joints and also in the absence of cutting or excessive wear at the ends of the rails.

A number of these rails recently made have been rolled 45 ft. in length instead of 30 ft., thus saving 33 per cent in the number of joints. About a mile and a quarter of track has been laid with the 45-ft. rails.




NEW STANDARD 80-LBS. RAIL, LEHIGH VALLEY RAILROAD.

This new section illustrates the tendency to use a heavier rail on all roads of large traffic, and it also shows where the experience of this road has proved that additional metal can be applied to the best advantage.

### Recent Patents.

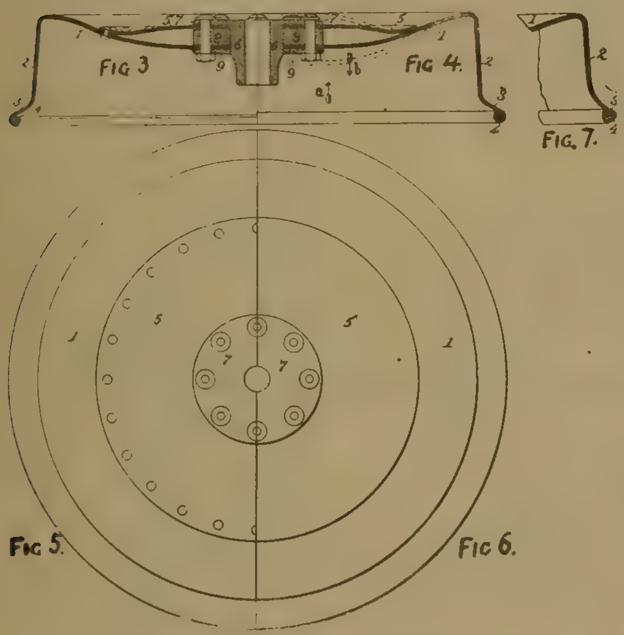
MANN'S CAR-WHEEL.

Figs. 3–7 show a form of car wheel covered by patent No. 433,950, issued recently to Henry F. Mann, of Allegheny, Pa. In the illustrations, fig. 3 is a sectional view of one-half of a car-wheel embodying this invention ; fig. 4 is a similar view of a modified form of the wheel ; figs. 5 and 6 are views in side elevation of the wheels shown in figs. 3 and 4, respectively ; and fig. 7 is a sectional detail of a further modification.

In practice the edge of a circular disk 1, of suitable dimensions is turned over to or approximately to a right angle to the body of the disk, said turned-over portion being of sufficient width for the formation not only of the tread 2 and flange 3, but also for the formation of a bead along the edge of the flange, which is formed by bending outwardly the edge of the portion turned over in forming the tread 2.

In forming the flange 3 metal of a width greater than that required for the flange should be bent outwardly, as above stated. This excess of metal is then bent over a ring 4, formed of heavy wire or wire rod. The metal inclosing the wing 4 may extend only partially around the wire, as shown in fig. 3, may be made to entirely embrace the ring, as shown in fig. 4, and the wire, wire rod, or tube forming the ring 4 may be round in cross-section, as shown in figs. 3 and 4, or angular, as shown in fig. 5, or it may be tubular, as the uses to which the wheel is to be put may require. It will be observed that by bending the metal over the wire the flange of the wheel is made sufficiently wide or thick to properly guide the wheel in passing over frogs, switches, and crossings—a function which this class of wheels as now constructed of a single thickness of metal does not properly perform.

In order to reinforce the web, which is dished, as shown, to enable it to better endure the strains of service, a concavo-convex metal disk 5 is secured to the web by rivets, as shown in fig. 4. The disk is arranged with its convex surface outward—that is to say, the disk is so placed that the concave surfaces of the disk and web shall be adjacent to each other, so that one




MANN'S STEEL WHEEL.

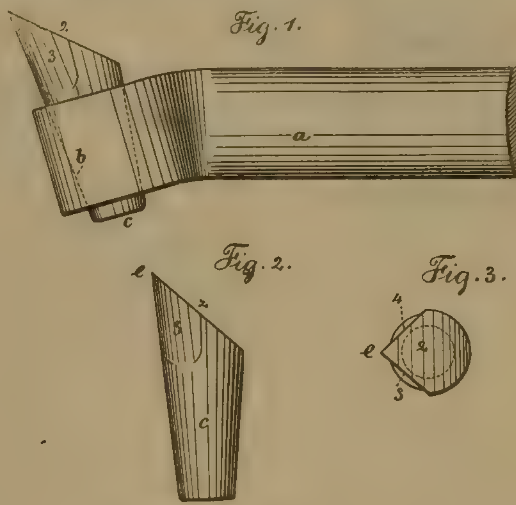
shall reinforce the other in the direction of the least rigidity. The web and disk are secured to the hub 6, which is provided with a flange 7 at one end, by bolts or rivets passing through said flange, an annular distance-block 8 interposed between the disk and web, and a washer 9, arranged outside of the web or disk.

In lieu of securing the disk to the web by rivets, as shown in figs. 3 and 5, the web and disk may be made with a deeper dish, as indicated by dotted lines in fig. 4, than required to obtain the relative adjustment of the disk and web, as shown in fig. 3, so that when said parts are placed together, with the edges of the disk resting upon the web, the distance between the two will be greater than desired in the finished wheel, and considerable power will be required to draw them into proper relation on the hub. It will be obvious that when so drawn into position the disk and web will bear against each other with a pressure proportional to the force required to bring them into the desired relation, and being under a strain will offer a more prompt and greater resistance as against lateral strains—as, for example, in the arrangement of the disk and web shown in fig. 4, the web will resist any outward strains in the direction of the arrow *a*, while the disk 5 will operate similarly as against strains in the direction of the arrow *b*.

This invention is also readily applicable to wheels wherein the web and tire are formed independent of each other and secured together by bolts or other suitable means.

### BUSSELL'S TURNING TOOL.

THE accompanying illustrations show a very neat and simple tool and tool-holder, which are protected by Patent No. 429,883, issued to Edward Bussell of New York. The tool-holder has a tapering eye, while the tool has a tapering shank made to fit

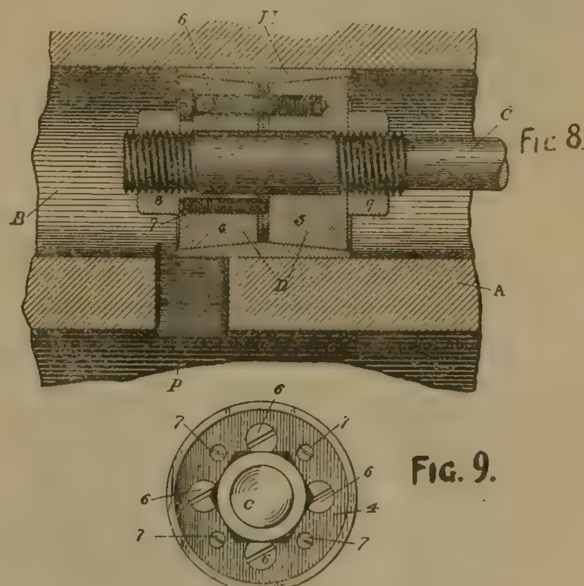



BUSSELL'S TURNING TOOL.

the eye, the end and side being ground off to form the cutting edge. Fig. 1 is an elevation of the tool and holder; fig. 2 a detached view of the tool, and fig. 3 an end view of the same. The holder is made of a bar *a* with an eye *b* at one end made tapering to receive the tapering shank *c* of the tool. At the end of the tool-shank *c* is the cutting edge *e*, formed of the inclined faces 2 and the side faces 3 4, ground to form a sharp cutting edge. The shank *c* wedges tightly into the eye *b*, but can be easily separated by a tap of the hammer on the smaller end and turned around into any desired position. In the same way a dull tool can be very easily removed and a new one substituted.

### RICHARD'S PISTON-VALVE.

Figs. 8 and 9 show a form of piston-valve covered by patent No. 430,484, issued to Francis H. Richards, of Hartford, Conn.




RICHARD'S PISTON VALVE.

Fig. 8 is a section and fig. 9 an end view. In fig. 8 the letter *A* shows part of a cylinder, in which the valve-seat *B* is bored. The valve-stem *C* has upon its outer end a core *D*, consisting

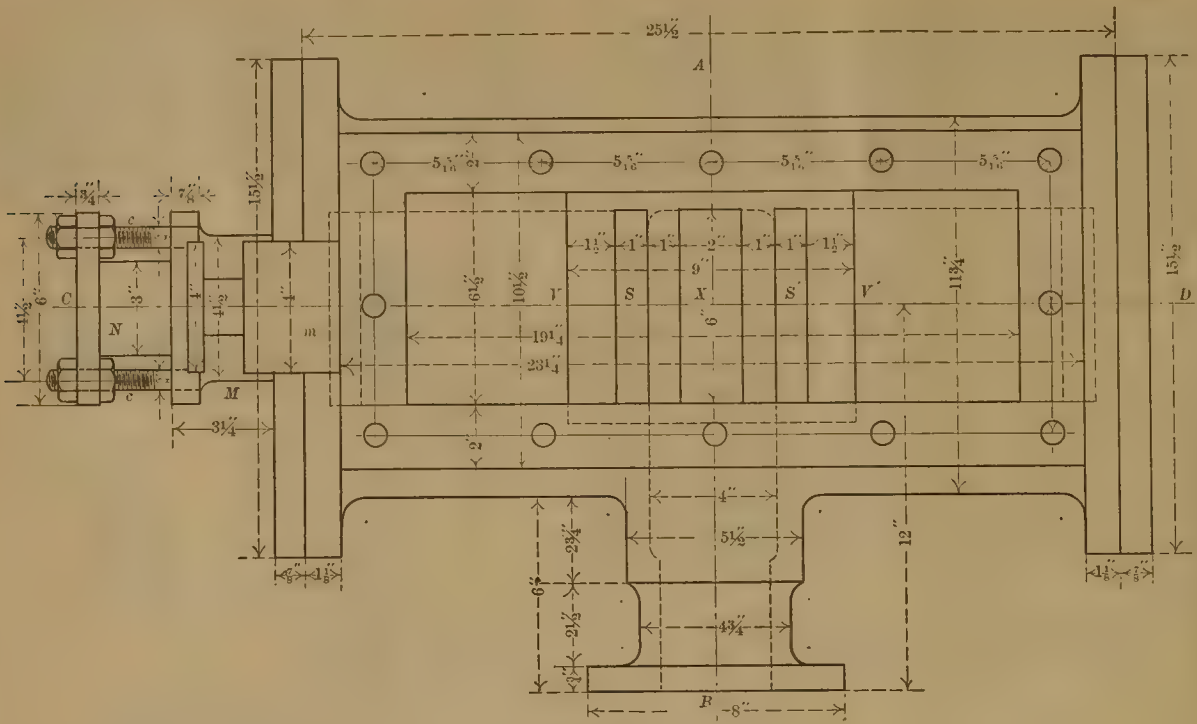



Fig. 207.

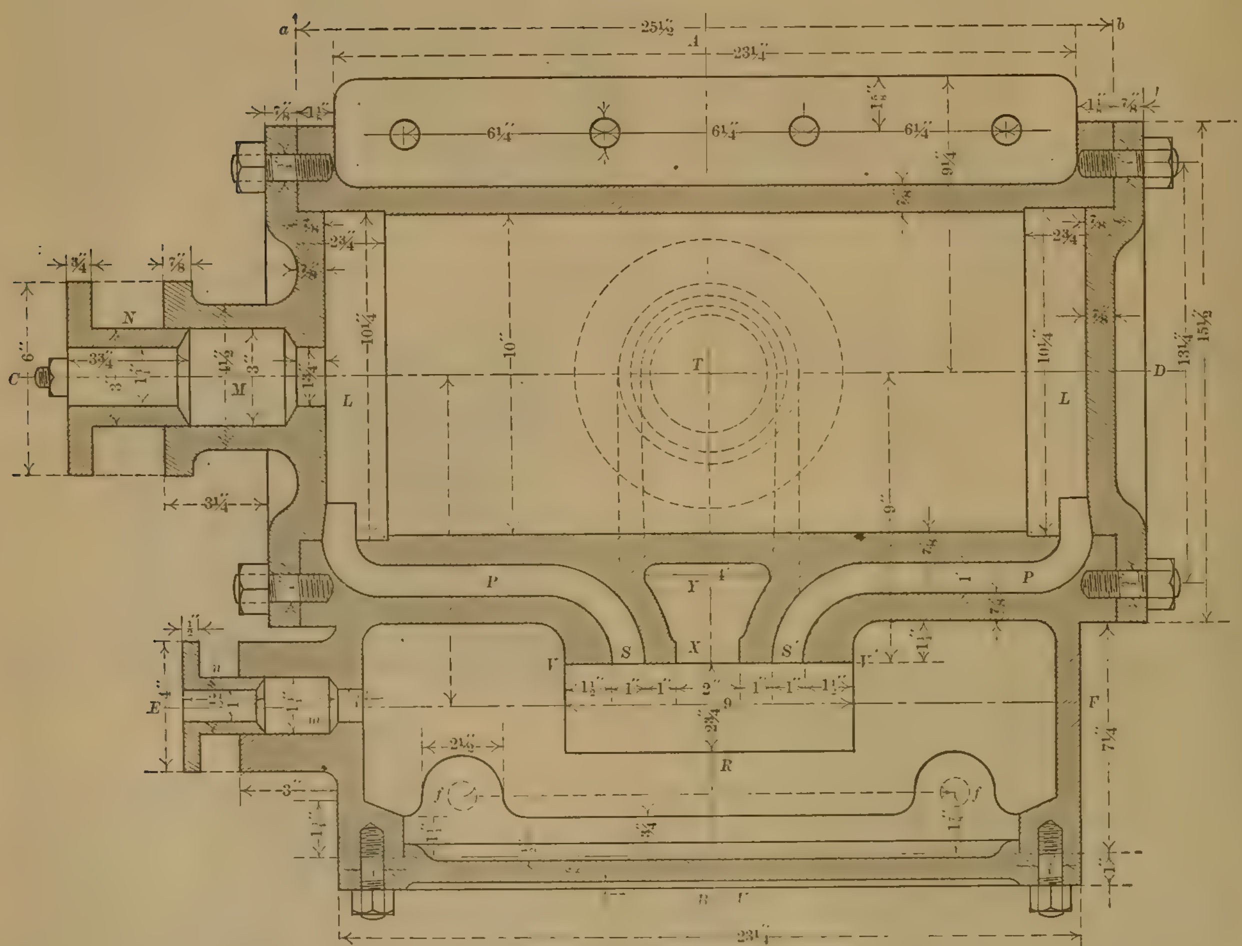



Fig. 208.

STEAM ENGINE CYLINDER. SCALE, 2 IN. = 1 FT.

of two parts 4 and 5, made coned or tapering inward toward each other. Surrounding these two cones is a shell *H*, having its bore or central opening tapering from both ends inward, so that there are within the shell two conical portions corresponding in shape with and adapted to be engaged by the peripheries of the two cones 4 and 5, forming the core *D*. The conical portions of the interior of the shell are, however, as shown in the drawings, made to taper down to a diameter less than that of the inner ends of the cones. Screws 6 6, passing through the outer cone 4 and tapped into the other one, serve to draw or force the two cones toward each other, while screws 7 7, tapped through the outer cone 4 and at their inner ends engaging cone 5, are employed to force and hold the cones apart. By means of the two sets of screws the cones can be adjusted to any desired distance apart and fixed as adjusted.

The core *D*, formed of the two adjustable cones, as described, is held in place on the valve-stem *C* by means of the nuts 8 and 9, screwed on the stem and engaging the ends of the outer and inner cones, respectively. With the core thus held by the nuts it can be not only securely fastened in place on the stem, but also adjusted as desired along the latter to change the position of the valve. The opposite ends of the shell *H* are preferably made of the same thickness where, as in motor engines, both ends of the piston-valve are alternately used to cut off air from port *P*.

The material of which the shell is made should be one having elasticity, or being capable of expansion and contraction without any slotting or division of the shell. The materials found in practice to be suitable for the shell are soft steel, bronze or cast iron, while for the core *D* steel is used. The taper of the cones and of the conical portions of the bore of the shell is made slight or at a small pitch, and that of either of the cones and the respective surface within the shell to be engaged by the cone is preferably made of the same pitch or at the same angle.

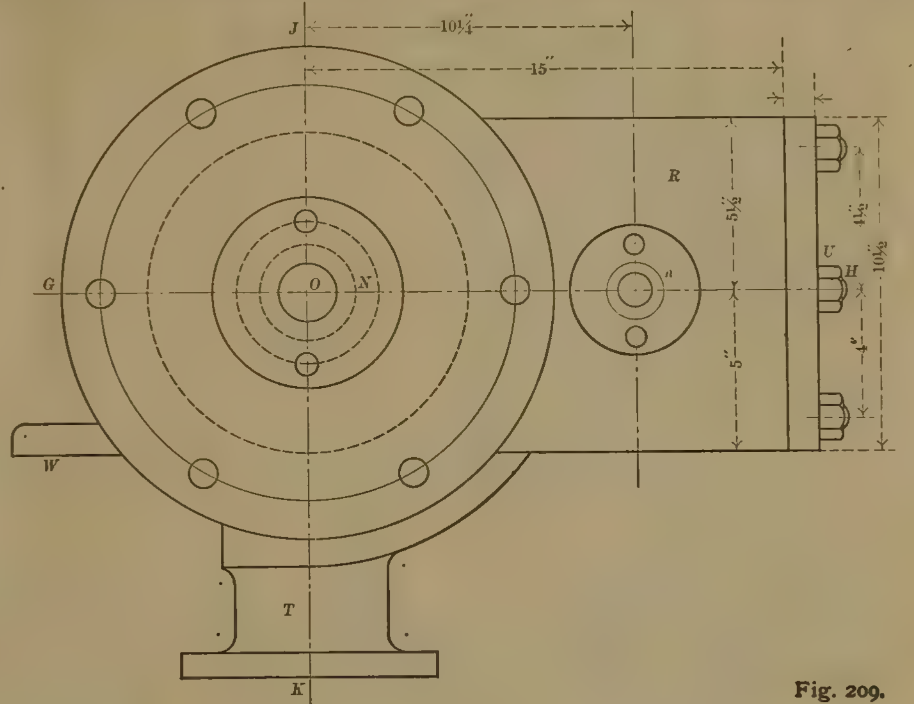



Fig. 209.

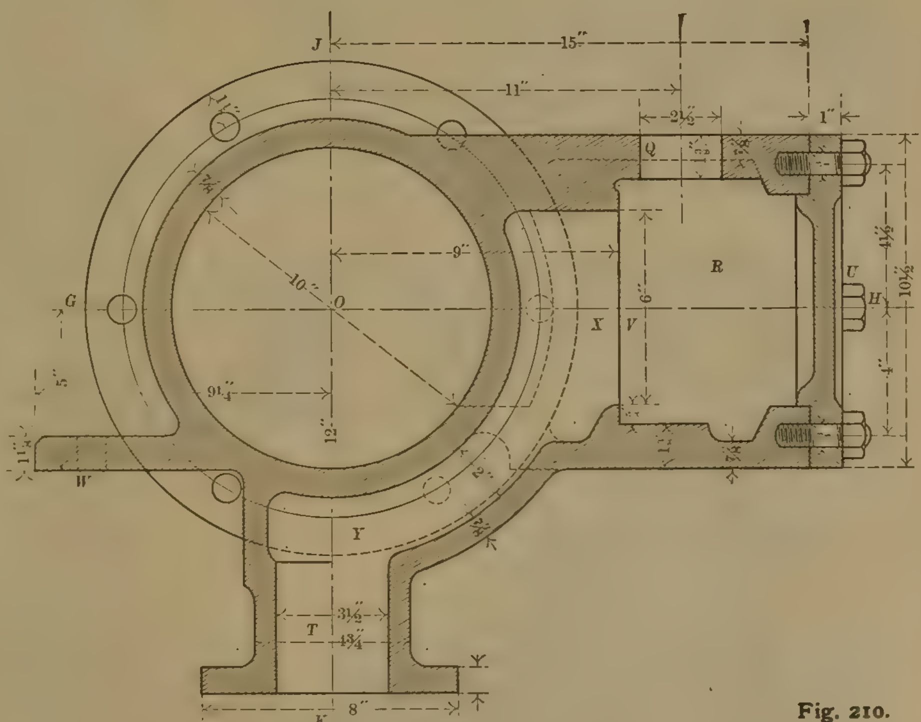



Fig. 210.

## THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.



(*Continued from page* 570, *Volume LXIV.*)

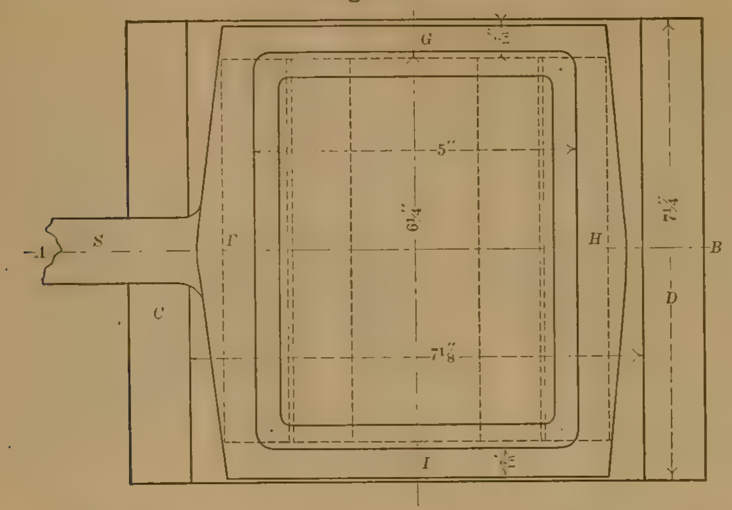
### CHAPTER VII.—(*Continued.*)

### THE STEAM-ENGINE.

#### CYLINDER.

Fig. 207 is a side view of a cylinder, with the cover of the steam chest removed; fig. 208 is a sectional plan drawn through the center of the cylinder; fig. 209 is a back end view, and fig. 210 is a transverse section on the line *A B* of figs. 207 and 208. These figures should be drawn half or quarter size. In drawing figs. 207 and 208 longitudinal center lines *C D*, *C D* should first be drawn. Vertical lines *A B*, *A B* passing through the middle of the cylinder should then be laid down. In figs. 209 and 210 horizontal center lines *G H*, *G H* and vertical lines *J K*, *J K* should form the base lines, from which other dimensions may be laid off. The inside diameter of this cylinder, as shown in figs. 208 and 210, is 10 in. Owing to the limited size of the pages of the Journal, figs. 207 and 209 and figs. 208 and 210 had to be placed opposite to each other. In drawing these the student should lay them all down on one sheet of paper, and the centers *O* and *O* should be in the center lines *C D* and *C D* extended. To begin with, circles 10 in. in diameter should be drawn from the intersections *O*, *O*, of the horizontal center lines *G H*, *G H*, figs. 209 and 210, with the vertical lines *J K*, *J K*, to represent the inside of the cylinder. As the sides of the cylinder

Fig. 211.



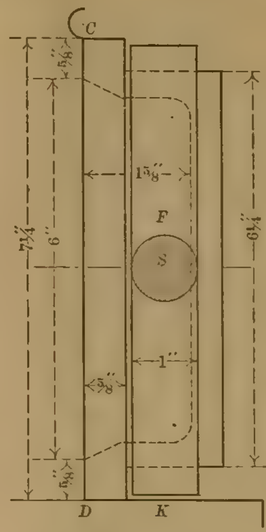


Fig. 212.

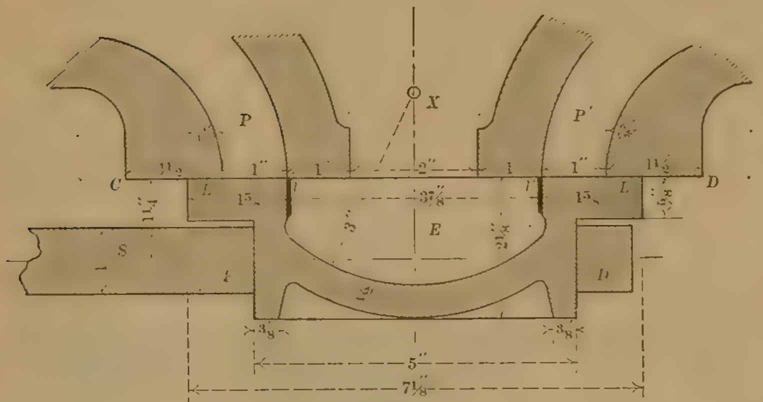


Fig. 213.

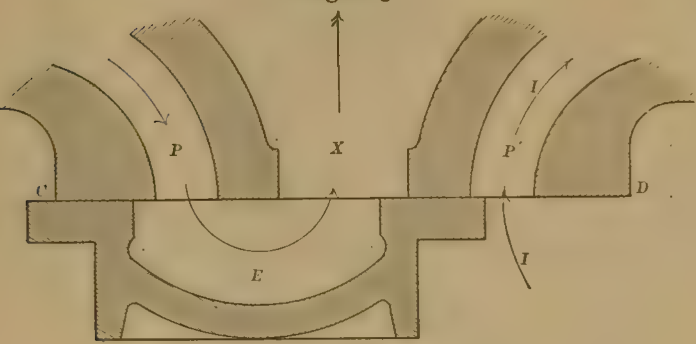


Fig. 214.

SLIDE VALVE. SCALE, 4 IN. = 1 FT.

are ¾ in. thick this dimension should be laid off outside of the circle, another circle should be drawn with a radius of 5⅜ in. from the center *O* through the point thus laid down. Then with the T-square lines can be projected in fig. 208, which will represent the inside and the outside of the cylinder. The length of the cylinder, as indicated by the dimension *a b*, fig. 208, is 25½ in. This should be laid off from the line *A B*. The diameter of the flanges and the cylinder-heads is 15½ in. Circles of this diameter, drawn from the centers *O*, *O*, figs. 209 and 210, will represent the heads and flanges. From the circumference of these circles lines can be projected with the T-square and drawn in figs. 207 and 208 to represent the outline of these parts. Their thickness, 1½ and ¾ in. respectively, can then be laid down in the figs. last referred to and lines drawn to represent it.

In boring steam-engine cylinders they are usually bored larger at each end, so that the piston will move slightly beyond the smallest part of the bore. This enlarged part is called the *counterbore*, and is shown at *L* and *L′* and is ½ in. larger in diameter than the other portion of the inside of the cylinder. The depth of the counterbore is 2¾ in. and is shown in fig. 208. The cylinder-heads, it will be seen, are made to project into the ends of the cylinders ¾ in. The heads are made "dished," as shown, the central part being the same thickness, ¾ in., as the outer rim.

The bolts or studs in the cylinder-heads are laid off in figs. 209 and 210 by drawing a circle the required distance inside of the circumference of the head, and then dividing it into the required number of spaces, in this case six. In figs. 209 and 210 the bolts are represented by circles only, the nuts being omitted. This is often done to save work. In fig. 208 the studs and nuts are shown in the section, and thus give all their dimensions.

In figs. 207 and 208 *M* and *m* are stuffing-boxes for the piston-rod and valve-stem. They consist of cylindrical-shaped openings *M* and *m*, fig. 208, which surround the rod and valve-stem. This space is filled with hemp or other fibrous material. What are called glands, *N* and *n*, which are hollow cylindrical-shaped pieces of metal, are then placed on the rods and are forced into the stuffing-boxes by bolts and nuts, *c c*, fig. 207. The fibrous material or packing, as it is called, is thus compressed and forms a steam-tight joint around the rods. To avoid confusion the bolts in the smaller stuffing-box *m* are not shown in the drawing.

*R* is a box or receptacle called a *steam-chest* to which steam is conducted by a pipe attached to the opening *Q*, fig. 210. From the steam-chest passages *P*, *P*, fig. 208, called *steam-passages* or *steam-ways*, communicate to each end of the cylinder. Another passage, *X Y*, figs. 208 and 210, forms a communication from the steam-chest *R* with a pipe *T*, called the *exhaust-pipe*, which, in high-pressure engines, is open to the atmosphere. These passages terminate in a flat surface *V V*, called the *valve-face*. The openings *S S*, fig. 207, in the valve-face, are called steam-ports, and *X* is the exhaust port. On this surface a slide-valve —whose construction will be explained hereafter—works, and alternately admits steam to one end of the cylinder and then to the other through the passages *P* and *P*, and also allows it to escape through the same channels and the exhaust-passage *X Y*. These passages are all cast with the cylinder and are of somewhat complicated form, so that the student will be obliged to study the engravings carefully to understand their shape and position. If he can examine a cylinder casting he will be able to understand them better than he can from an engraving alone. It is doubtful whether further explanation will aid him in getting a clearer understanding of the construction of a cylinder.

The steam-chest in the present illustration is cast with the cylinder and forms a part of the same casting. The cover *U* is bolted to the chest by the studs which are clearly shown in the engraving. The flange *W* is for fastening the cylinder to the engine-frame. The bolts *f*, *f*, represented by dotted circles in fig. 208, are also for fastening the cylinder to the frame.

### SLIDE-VALVE.

The slide-valve for the engine, which has been illustrated by the preceding engravings in this chapter, is shown by figs. 211–214. These engravings should be drawn by the student either

half or full size. Fig. 211 is a side view of the valve, fig. 212 an end view, fig. 213 a sectional plan on the line *A B*, of fig. 211, and fig. 214 is another similar plan with the valve in a different position from that shown in fig. 213. *C D* is the valve-face, which in this case stands vertical. In many engines, especially locomotives, it is usually placed horizontal. *P P'* are the steam and *X* the exhaust-passages. The openings where these emerge into the valve-seat are called *steam* and *exhaust-ports*.

The action of the valve may be readily understood from figs. 213 and 214. In fig. 213 the valve is shown on the middle of its seat, and it then covers both the steam-ports and the exhaust-port. In fig. 214 the valve has been moved toward the left side of the valve-seat and has uncovered the steam-port *P'*. As the valve is inside of the steam-chest, if steam is turned on and the chest is filled with steam it will flow into the port *P'*, when it is uncovered, as indicated by the darts 1 1, and will be conducted to the front end of the cylinder. At the same time the exhaust cavity *E*, in the valve, covers the steam-port *P* and exhaust-port *X*, and communication is thus established between the front end of the cylinder and the exhaust-passage *X*, and the steam in the front end of the cylinder can thus escape into the open air. When the valve is moved to the right the reverse action occurs—that is, the steam-port *P* is uncovered and steam then flows into it and the exhaust-cavity covers *X* and *P'*, so that the steam in the front end of the cylinder can escape. The valve is moved by the eccentric alternately back and forth with each stroke of the piston, and thus admits and exhausts steam alternately from one end and then from the other of the cylinder.

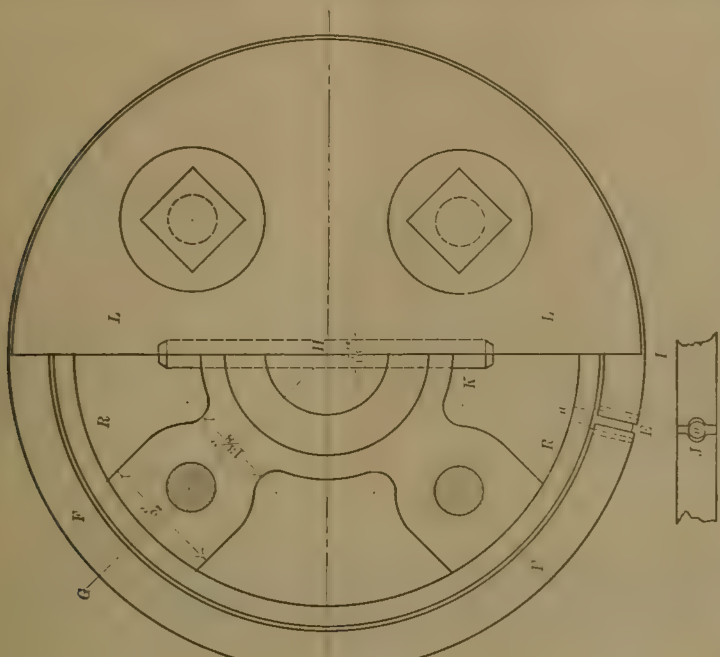


Fig. 216.

PISTON. SCALE, 4 IN. = 1 FT.

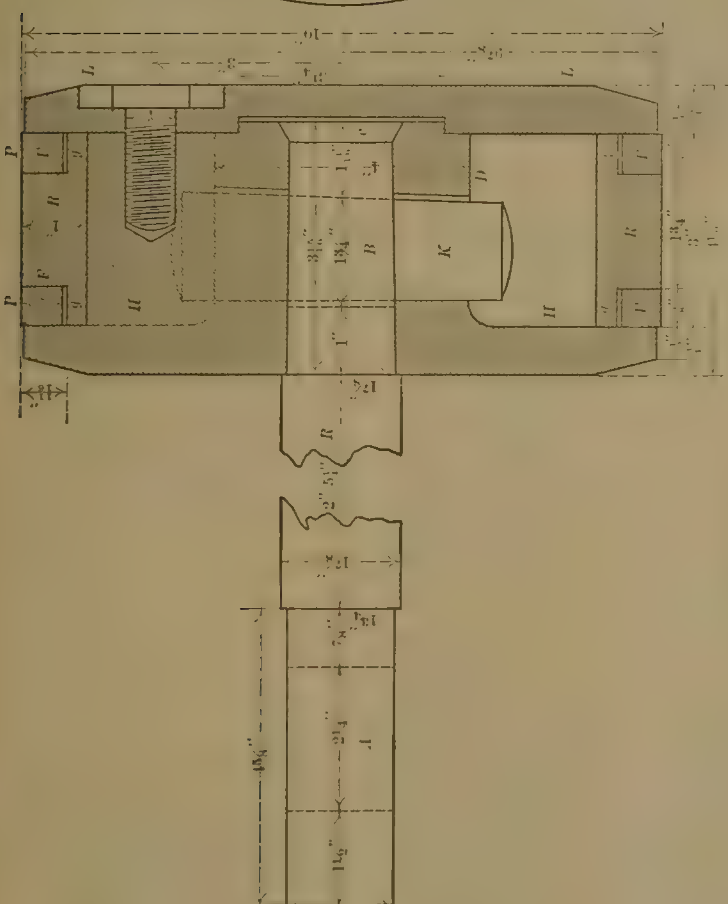


Fig. 215.

It will be noticed from fig. 213 that the outer portions *L L* of the valve, shaded with double lines, overlap the edges of the steam-ports. This double shaded part is called the "*outside lap*," or simply the "*lap*" of the valve. This performs a very important function in its working, as it covers the parts and encloses the steam in the ends of the cylinder and allows it to expand during the time that the ports are closed, and until they are opened by the inside edges *l* and *l'* and the steam is then allowed to escape.*

In order to prevent both of the steam-ports from communicating with the exhaust-port at the same time, the inside edges of the valve *l l'* usually have a small amount of lap called "*inside lap*," and indicated by black shading in the fig.

Motion is communicated to the valve by means of a rod *S*, called the *valve-stem*, which has what is called a "*yoke*," *F G H I*, fig. 211, on its end. This has a square opening in it which fits over the valve, as shown in the engraving. The valve-stem passes through the stuffing-box *M*, fig. 207 and 208, in the steam-chest, which prevents the leakage of steam from the chest. The dotted lines in fig. 212 show the form of the cavity *E* in the inside of the valve. The weight of the valve rests on a slide *D K* below it. This serves merely to carry its weight.

PISTON.

In the construction of pistons a great variety of methods have been adopted to make them work steam-tight in the cylinder. Figs. 215 and 216 represent what is called Stevenson's packing.

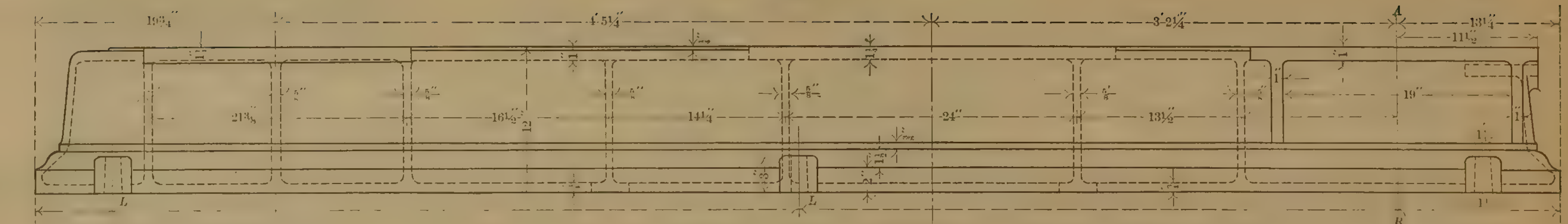
Fig. 215 is a section on the line *G H I* of fig. 216, and in the latter fig. the left hand half is represented with the plate *L L* removed. These figs. should be drawn full size.

The piston consists of a cast-iron head, *H H*, which is fastened to the piston-rod *R*. The ends *A* and *B* of the rod are made of a conical form, and the one end *B* fits into a similar shaped hole in the piston-head. This end of the rod is riveted, as shown at *c*, to hold the piston-head on the rod. Besides the riveting a tapered key *K* passes through the boss *D*, and the rod so as to hold the piston-head securely to the rod. The other end, *A*, of the rod fits into the cross-head, as shown in figs. 203–205.

A solid cast-iron ring, *R R*, with grooves *g g* in it, encircles the piston-head. Two other smaller rings, *F F*, called *packing-rings*, are placed in the grooves *g g*. The outside diameter of these packing rings is made somewhat larger than the inside of the cylinder, and they are then each cut apart transversely, as shown at *E*, fig. 216. This permits them to be sprung together so as to enter the cylinder, and their elasticity then causes them to expand and fit the cylinder. An inverted plan

* For a fuller explanation of the action of a slide-valve the reader is referred to the Author's "Catechism of the Locomotive," Second Edition.

Fig. A.



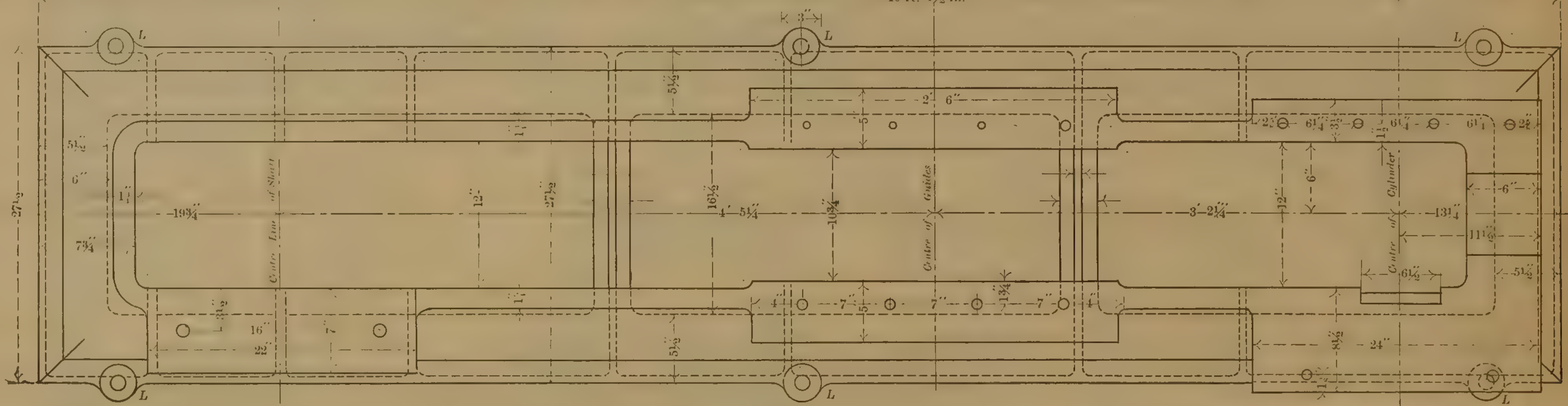




Fig. B.

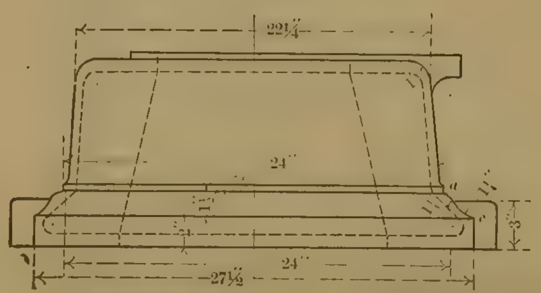



Fig. C.

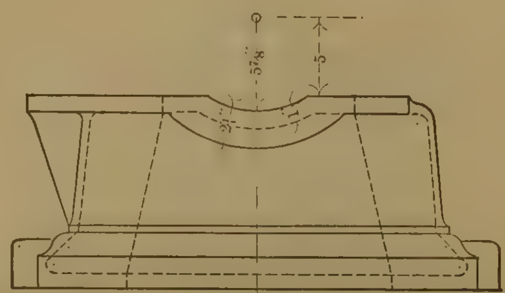



Fig. D.

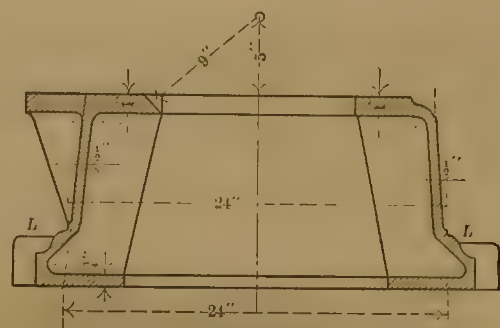



Fig. E.

PLATE I.

ENGINE FRAME.

SCALE 1 IN. = 1 FT.

of the packing ring, where it is cut apart, is shown at *J*. A small pin *n* is attached to the ring *R* and prevents the ring *F* from turning.

The solid ring *R* and the two packing rings are held in their places by a plate *L L*, called a *follower-plate*, which is bolted to the front of the piston-head.

ENGINE-FRAME.

Figs. *A*, *B*, *C*, *D* and *E* represent a cast-iron engine-frame, which should be drawn by the student to a scale of 3 in. = 1 ft. Fig. *A* is a side view, *B* a plan, *C* a back-end view, *D* a front-end view, and *E* a transverse section on the line *A B* of fig. *A*. In drawing fig. *A* the line representing the top and that representing the bottom of the frame should be drawn first. Then lay out the longitudinal center line for the plan, and on this locate the transverse center lines of the shaft and that which passes through the middle of the guides and the middle of the cylinder shown by dotted lines in the engravings. These can be extended to intersect the top and bottom lines of fig. *A*, and from them the lugs and flanges to receive the pedestal guides and cylinder can be laid off.

The frame is cast hollow, as shown by fig. *A*, but has transverse ribs on the inside—represented by dotted lines in the figs.—to strengthen or stiffen it. The lugs *L L*—*L* are intended to receive bolts, which are imbedded in masonry and hold the frame securely to its foundation.

The drawing presents no special difficulties, excepting, perhaps, the moulding around the base. In fig. *C* the vertical and horizontal width of the members of this moulding are shown. Lay these down and unite the points *a* and *c* with a straight line. Subdivide this line and then draw in the curves, as explained in Problem 64.

(TO BE CONTINUED.)

### The Business Boat of the Lakes.

(From the Cleveland *Marine Review*.)

A LIKENESS of the propeller *North Wind*, which accompanies this, is a fair representation of the business boat of the lakes. The *North Wind* is one of a fleet of six steel steamships, owned by the Northern Steamship Company, the lake line of the Great Northern Railroad Company between the head of Lake Superior and seaboard connections at Buffalo. As this fleet will have carried between the opening and close of navigation 500,000 tons of freight including 1,300,000 barrels of flour, they may well be classed among the money makers, and the immense tonnage credited to them shows the extent of the lake trade outside of the millions of tons in the coal and ore business. But they are unable to meet requirements even in connection with the railroad, and preparations are being made for increasing the fleet in the near future by an addition of four steamers, two of which will, in all probability, be passenger steamers, elegantly equipped and so arranged that they can be used for freight traffic when the passenger season is over, carrying 3,500 tons of freight through the Sault Canal. President James J. Hill, of the Great Northern Company, is expected in Buffalo shortly to consider the matter of new boats.

The *North Wind*, like the other boats of this fleet—they are duplicates in every respect and were built by the Globe Iron Works Company—cost her owners $223,000. She is 292 ft. keel, 312 ft. over all, 40 ft. beam, and 24½ ft. moulded depth. Her triple-expansion engines are 24, 38, and 61 by 42, and she has two boilers 14 × 12½ ft. She has four gangways on either side and six hatches for the handling of freight. A line shaft with two drums to each hatch enables the boat to handle 96 barrels of flour at one time, as each of the drums handle eight barrels. The boats are capable of carrying about 2,500 net tons on 15 ft. of water through the Sault Canal. The boats are thoroughly equipped in every way, the *Northern Wave* being fitted with an Edison electric light plant, and the entire fleet have Providence windlasses. Electric plants will be placed on all of the other boats of the line during the coming winter.

STEAMSHIP "NORTH WIND."

# Manufactures.

## General Notes.

THE Buffalo Railroad Supply Company, which was recently incorporated with a capital stock of $100,000, has purchased five acres of land at the crossing of the Delaware, Lackawanna & Western, the Lehigh Valley, and the Western New York & Pennsylvania Railroads in Buffalo, and has begun the erection of large buildings, the principal one being 500 ft. in length and another 250 ft. These buildings will be fitted up with new machinery, and work will be begun as soon as possible. The Company will manufacture switches and fixtures, frogs and crossings, car-axles, links and pins, and many other articles used by railroads, besides making brass and iron castings of all descriptions and general machinery. It has succeeded to the business of the Buffalo Frog & Crossing Company, and has also acquired control of several patents for feed-water heaters, and purifiers for boilers. The officers of the Company are: Sydney E. Adams, President; M. M. Drake, Vice-President; W. A. Clemens, Treasurer; Virgil H. McConnell, Secretary and Manager. There are many advantages in Buffalo as a location for such business.

THE Arrow Steamship Company has one of its peculiar type of vessels now building in the yard of the Monumental Construction Company, Locust Point, Baltimore, under the super-

vision of the inventor, Robert N. Fryer. This vessel will be of iron, 222 ft. long over all; 16 ft. extreme breadth; 18.4 ft. deep, and will have a draft of 8 ft. forward and 10 ft. aft. Great expectations are entertained of this vessel, but its success is considered by experts somewhat doubtful. The ship will be propelled by a compound engine with cylinders 30 and 60 in. in diameter and 24 in. stroke, steam being furnished by two Ward boilers.

THE Detroit Dry Dock Company has let a contract for the building of a new dry dock, which will be the largest on the lakes. It will be 400 ft. long, 54 ft. wide at the bottom and 94 ft. on the water-line, with 16 ft. of water over the keel blocks at low water. The pumps will have a capacity of 36,000 galls. per minute. The dock has been designed by Mr. Frank E. Kirby, and will be of wood with a steel caisson gate.

ONE of the largest sailing ships in the world is the *Shenandoah*, which was recently launched from the yard of Arthur Sewall & Company in Bath, Me. This ship is 325 ft. in length over all; 49 ft. beam, and 28 8 ft. in depth, with a registered gross tonnage of 3,407 tons. She will carry 5,000 tons of freight, and with that load will draw 27 ft. of water. She will have four masts and a total sail area of 11,000 yards. The rigging is all of wire, and all her fittings are of the most modern type, including steam windlass and hoisting drums, capstans, and power pumps. The keel and frames are of oak and hackmatack, and the upper works principally of yellow pine.

THE Bucyrus Steam Shovel & Dredge Company, Bucyrus, O., has sold two of its large shovels to the Cleveland Iron Mining Company and one to the Lake Angeline Mining Company. These shovels are made for handling hard and soft ore, and have a capacity of five tons per minute. It is claimed for them that they will load ore at about one-third the expense of hand labor.

A NEW wrought-iron paint which has been put upon the market is, it is claimed, the best existing material for protecting iron and steel surfaces from the influence of the weather. This paint is made from slag produced at a very high temperature, and the manufacturers claim that its constituents are present as chemical compounds, chiefly silicate of iron, unalterable under the conditions to which a pigment is liable to be exposed. The great weight of the pigment causes it to settle rapidly to the surface to which it is applied, and it clings to that surface with great tenacity, forming a layer of unusual durability. The vehicle used is pure linseed-oil, and no artificial dryer is required. This paint is laid on with a brush in the same way as ordinary paint, but the layers are heavier. It dries more rapidly than ordinary paint, and has, it is claimed, much greater adhesive power and resistance to water, air and other corroding elements. It is made in different colors for freight cars, car roofs, for bridges, and, in fact, for all iron and other work exposed to the weather. It is manufactured by the Aquila Rich Paint Company, of New York.

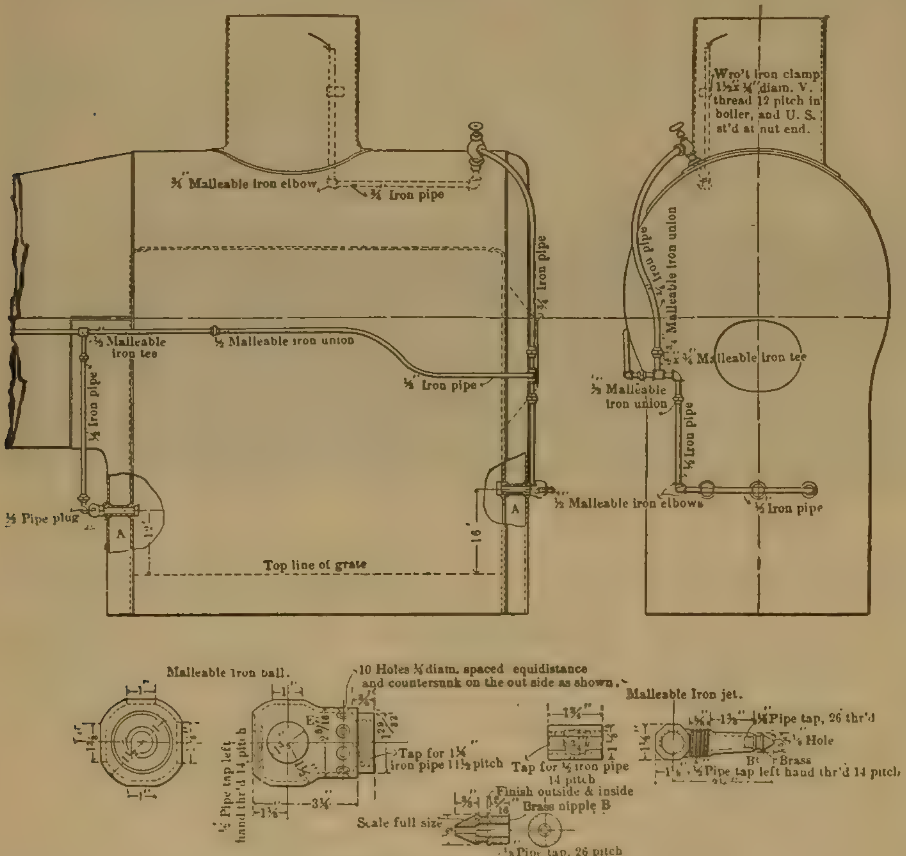
THE Bethlehem Iron Company, Bethlehem, Pa., has done a large amount of forging for the new cruisers of the Navy, a number of shafts and cranks having been made in the works. These include the shafts for the *San Francisco* and the *Monterey*, built by the Union Iron Works in San Francisco, the total weight of forgings for the former being 147,202 lbs. and for the latter 68,161 lbs. On the ships built in the Cramp yard in Philadelphia, the weight of forgings furnished was 147,113 lbs. for the *Philadelphia* and 118,820 lbs. for the *Newark*. For the engines of the *Maine*, under construction at the Quintard Works in New York, the weight of the forgings was 119,810 lbs. For cruisers Nos. 7 and 8, building at the New York and Norfolk navy yards, 53,579 lbs. of forgings were made. The total amount of heavy forgings thus furnished for the Government vessels to date is 756,621 lbs. altogether.

IT is stated that a half interest in the Priest flanger has been sold to Mr. W. E. Haskell, of Minneapolis, and that this invention, which has already met with much success, is to be actively pushed.

LAKE shipments of iron ore for the season are at an end, and the aggregate, 8,155,324 gross tons, is 1,251,324 tons greater than the shipments of 1889 and 3,433,337 tons greater than the shipments of 1888. Rail shipment of about 400,000 tons will bring the 1890 record up to 8,500,000 gross tons, or double that of all years previous to 1888. Shipments from the different ports were: Escanaba, 3,756,143 tons; Ashland, 2,109,511 tons; Marquette, 1,316,353 tons; Two Harbors, 870,848 tons; Gladstone, 86,558 tons, and St. Ignace, 15,911 tons. The Marquette Range shipped 2,656,423 tons; Gogebic, 2,460,569 tons; Menominee, 2,167,484 tons, and Vermillion, 870,848 tons.—*Cleveland Marine Review.*

THE Baldwin Locomotive Works in Philadelphia have received an order for 10 ten-wheel passenger locomotives for the New York, Lake Erie & Western Railroad.

THE Buffalo Car Manufacturing Company has just completed 200 box cars of 50,000 lbs. capacity for the Delaware, Lackawanna & Western Railroad.




HUTCHINSON'S SMOKE CONSUMER.

## The Hutchinson Smoke Consumer.

THE accompanying illustrations show a device for preventing smoke which has been prepared by W. S. Hutchinson, of Chicago, and has been introduced on the Lake Shore & Michigan Southern, the Baltimore & Ohio, the Chicago & Northwestern, the Chicago, Rock Island & Pacific and other roads.

The cuts, which include a rear and side view of the boiler and a plan and section, on a larger scale, of the steam-jet, show the device as applied to a Lake Shore locomotive. In this case the pipe was carried forward to supply a blower in the smokebox, but that connection is a separate thing and independent of the smoke consumer.

The principle involved, as will be seen from the engravings, is simply that of a steam-jet to carry air into the fire-box above the fire, thus securing the consumption of the gases, etc., which would otherwise pass off through the flues and the smoke-stack. These jets are placed at each end of the fire-box, as shown, and are so arranged as to distribute the air over the surface of the fire.

The results obtained are said to be very good. The device can be applied to stationary boilers as well as to locomotives, as will be readily understood from the description.

### Notes from Baltimore.

THE Maryland Central Railroad is to be changed from 3 ft. to standard gauge, so as to be able to exchange traffic with other lines. The connection will be made over the new Baltimore Belt Line.

WORK is being pushed on the extension of the Western Maryland Railroad from its present terminus in Baltimore to tidewater.

SEVERAL new establishments have been located at Curtis Bay, adjoining the South Baltimore Car Works. The South Baltimore Foundry Company has completed its plant and is now filling orders. Foundations have been laid at the same places for the Ryan-McDonald Machine Works. These works will be under the management of Mr. Howard Carlton, who is also General Manager of the Car Works.

THE proposed plan for using the bed of the Chesapeake & Ohio Canal for a railroad will not be carried out. The Baltimore & Ohio now has control of the canal, and is making arrangements to repair it and put it in operation.

THE Mt. Clare Works of the Baltimore & Ohio Railroad are busy on new work, having orders for six new consolidation engines, ten 10-wheel engines and four 8-wheel, class M, engines. In addition to this equipment, orders have been given to the Baldwin Locomotive Works for seven 10-wheel engines and for three 8-wheel passenger engines, the latter having driving-wheels 76 in. in diameter. The Company is putting up new shops just outside of Washington at a place which will be called Trinidad.

AT a general meeting of officers of the Operating Departments of the Baltimore & Ohio Railroad, held at Camden Station, in Baltimore, December 5, satisfactory reports were presented. President Mayer and Vice-President Orland Smith were present and made short addresses. The supply of fuel and oil were two of the subjects discussed.

THE heads of the Motive Power Department of the Baltimore & Ohio recently held a conference at Mt. Clare with a view of preparing forms to be used in connection with the piecework system. This system is in use in the shops east of the Ohio River, but some difficulty has been found in getting satisfactory forms for all classes of work.

### New Bridges.

A NEW bridge over the Genesee River at Rochester, N. Y., has recently been completed by the builders, the Rochester Bridge & Iron Works. This bridge crosses the deep gorge of the Genesee at a height of 212 ft. above the river, and consists of one main three-hinged arch span 428 ft. in length, with a single approach span of 103 ft. at the east end and two approach spans of 93 ft. each at the west end, the total length being thus 717 ft. The depth of the main arch at the center is 14 ft. and at the ends 82 ft., the spring being 68 ft. The arch is composed of two trusses, which are inclined toward each other, being 20 ft. apart at the center and 46 ft. at the points of support. The bridge carries a roadway 20 ft. in width, and two sidewalks each 8 ft. wide.

THE new Verrugas Bridge on the Lima & Oroya Railroad, in Peru, has been completed. It replaces the famous Verrugas Viaduct, which was built in 1871 and destroyed by a flood in March, 1889. The new bridge will be secure from such an accident, as there are no piers in the center of the ravine which it crosses, and the failure of the old viaduct was caused by the undermining of the piers. The bridge, which was designed by Mr. L. L. Buck, is of the cantilever type, and is supported on two iron piers. The cantilever arms are each 235 ft. long and the suspended span is 105 ft. At the center it is 250 ft. above the bottom of the valley.

The Oroya Railroad has its present terminus at Chicla, 87 miles from Callao, and 12,300 ft. above the sea level. Arrangements are being made to complete the road from that point to the Cerro Di Pasco mines, and thence to some point on the upper waters of the Amazon. This was the plan originally laid down for the road, but interrupted by circumstances.

### The Sault Ste. Marie Canal.

SOME idea of the importance of this canal may be formed from the following comparative statement of the business passing through it for the seasons of 1890 and 1889:

| | 1890. | 1889. | Increase. | Per ct. |
|---|---|---|---|---|
| No. of lockages.............. | 4,970 | 4,684 | 286 | 6 |
| No. of vessels passed ......... | 10,557 | 9,579 | 978 | 10 |
| Registered tonnage............ | 8,454,425 | 7,221,935 | 1,232,490 | 17 |
| Tons freight carried........... | 9,041,213 | 7,516,022 | 1,525,191 | 20 |
| Estimated value of freight ... | $102,214,949 | $83,732,527 | $18,482,422 | 22 |

The average tonnage of freight carried per vessel this year was 856 against 784 in 1889, indicating an increase in the size and capacity of ships. The vessels passing the canal this year included 7,268 steamers, 2,872 sailing vessels, and 417 unregistered craft. The largest items of freight recorded were iron ore, coal, grain, and flour.

The *Marine Review* says: "Plans and specifications for the continuance of work on the new lock at Sault Ste. Marie have been completed in the office of General O. M. Poe, U. S. Engineers. This is the new work for which $900,000 were appropriated in the river and harbor act of September 19, with a proviso also that such contracts as may be desirable may be entered into by the Secretary of War for materials and labor for the entire structure and approaches, or any part of the same, to be paid for as appropriations may from time to time be made by law. Work under the contract shall be begun on or before May 15, 1891, and entirely completed on or before November 15, 1893. The approximate estimate of materials to be furnished and work to be done under the specifications is as follows: Portland cement to be delivered, 22,000 barrels; natural cement, 75,000 barrels; cut stone to be delivered, 20,000 cub. yds., solid measure; cut stone to be laid, 20,000 cub. yds., solid measure; backing to be delivered, 55,000 cub. yds., solid measure; backing to be laid, 59,000 cub. yds., solid measure; concrete to be laid, 5,000 cub. yds., measured in place; earth to be filled behind walls, 70,000 cub. yds., measured in place. The work required by the specifications is the building of the main walls and stairways of the 800-ft. lock, and the furnishing of all material, labor, and appliances needed for this purpose. The general character of the proposed work is similar to that of the lock now in use, which is called the lock of 1881 in the specifications, and the general outline of the work will be as shown in the drawings to be seen at the United States Engineer's Office, Detroit. The engineering skill necessary in the building of the new lock will again attract attention to great works on the lakes."

## OBITUARY.

MAJOR P. W. O. KOERNER, who died in Atlanta, Ga., November 30, made the surveys for the first railroad proposed in Florida. He located the Florida Transit Road from Fernandina to Cedar Keys, and was engaged on several other railroads in the State.

MOORES MIRICK WHITE, who died in New York, November 29, was a pioneer among builders of iron bridges. He was a merchant at Syracuse, N. Y., for some years, and afterward engaged in bridge building, in which business he remained for a number of years. He was 81 years old at the time of his death, and retired from business some time ago.

THOMAS JEFFERSON WHITMAN, who died in St. Louis, November 25, aged 57 years, was born in Brooklyn, N. Y., and studied civil engineering under Mr. Kirkwood, who constructed the water-works of that city. In 1859 he removed to St. Louis, where he was engaged in planning and building the water-works, of which he was Chief Engineer and Superintendent for over 20 years. For some time past ill health has prevented him from engaging in active work.

WILLIAM B. KNIGHT died in Jacksonville, Ill., December 6, from injuries received in a railroad accident a few days before. He was born in New York in 1847, and was educated at the Rensselaer Polytechnic Institute in Troy, N. Y. He served as engineer on the New York Central, on the Panama Railroad, and on the sewerage works of Boston. In 1879 he removed to

Kansas City, where he was engaged in a number of important works, including the principal cable and electric railroad lines of the city. He was for four years City Engineer and held other responsible positions.

## PERSONALS.

F. S. CURTIS has resigned his position as Chief Engineer of the Sinnemahoning Valley Railroad.

WOLCOTT C. FOSTER, of New York, has charge of the construction of the new water-works at Tarrytown.

W. H. KIPPLE has been appointed Chief Inspector of bridge and track material of the Pennsylvania Railroad.

S. H. OPDYKE, JR., has resigned his position as General Superintendent of the Central New England & Western Railroad.

CHARLES E. BILLIN has been appointed Superintendent of the Bridge and Construction Department of the Pennyslvania Steel Works.

J. W. PALMER, of Macon, Ga., is now Resident Engineer in charge of construction on the eastern end of the new Macon & Atlantic Railroad.

J. R. ROHRER has been appointed Division Engineer in charge of construction on the Ohio Extension of the Norfolk & Western Ohio Railroad.

S. H. H. CLARK has been appointed General Manager of the Union Pacific Railway. He will also retain his position as Vice-President of the Missouri Pacific.

WILLIAM F. TURREFF has been appointed Master Mechanic of the Chicago & Erie Railroad. He was formerly on the Cleveland, Cincinnati, Chicago & St. Louis.

ROBERT B. CABLE, recently on the Philadelphia & Reading, has been appointed General Manager of the Jacksonville, Tampa & Key West Railroad in Florida.

W. F. DONOVAN has been appointed General Manager of the Yale & Towne Manufacturing Company in place of SCHUYLER MERRITT, the last-named gentleman remaining with the Company as Secretary.

WILLIAM VOSS, formerly Master Car-Builder of the Burlington, Cedar Rapids & Northern Railroad, and later with the Fox Solid Pressed Steel Company, is now Master Car-Builder of the Illinois Steel Company.

GENERAL JOHN NEWTON, of New York, has been appointed Consulting Engineer to the Board of Trustees of the Chicago Sanitary District, and will have charge of the location and construction of the proposed drainage canal.

CHIEF CONSTRUCTOR T. D. WILSON, U. S. N., has been appointed Chief of the Bureau of Construction and Repair for a third term of four years. It is unusual for the Chief of a bureau in the Navy Department to serve more than two terms, and Mr. Wilson's reappointment is therefore a compliment to him, which will meet with general approval.

LEON G. BAGLEY has been appointed Railroad Commissioner of Vermont by the Governor of the State. Mr. Bagley began life as a messenger boy in St. Johnsbury, Vt, and rose to be Station Agent in that town. He subsequently removed to Rutland and was made Manager of the Western Union Telegraph office there, but was afterward in the marble business and more recently General Manager of the New England Insurance Company. His appointment to the Railroad Commission as a business man was strongly endorsed.

CHARLES FRANCIS ADAMS, JR., has retired from the office of President of the Union Pacific Company, in consequence of the recent changes in the controlling interest in the stock. Mr. Adams has been for a number of years recognized as one of the foremost authorities on railroad subjects. There has been a disposition in certain quarters to criticise Mr. Adams' management of the Union Pacific as not practical, but this is certainly not warranted, nor would such a position be taken by any one who knew the real condition of the Company when he was placed at its head. Few men have held a more difficult position than that he was called upon to fill; and it may be added that few could have filled it as he did.

COMMODORE CHARLES H. LORING, U.S.N., was placed on the retired list of the Navy December 18, having reached the statutory age of 62 years. He has seen 39 years of continuous and honorable service. He began his service in 1851, when he was appointed Third Assistant Engineer and assigned to the steam sloop *John Hancock.* From that time until he saw his last sea service as Fleet Engineer of the Asiatic Squadron, he served on all the principal ships of the Navy, including the *Princeton, St. Louis, Cincinnati, Susquehanna, Merrimac*, and *Minnesota.* He rose gradually to the rank of Chief Engineer, and in 1884 was made Chief of the Bureau of Steam Engineering. In 1888 he was relieved by Commodore Melville, and has since been on duty as President of the Experimental Board, with headquarters at the Brooklyn Yard.

## PROCEEDINGS OF SOCIETIES.

**American Society of Civil Engineers.**—At the regular meeting in New York, December 3, the Secretary announced the death of Thomas J. Whitman, St. Louis, Mo., formerly Vice-President of the Society. Amendments to the Constitution and a report prepared by the Committee on Revision were ordered printed and sent out. The Secretary read a list of a number of nominations which had been made for office.

Mr. J. A. Hall read an interesting paper on the Construction and Maintenance of Track, giving his own opinions and methods of practice, with a view to drawing out general discussion upon the same.

The tellers announced the following elections: *Members:* George H. Kimball, Cleveland, O.; H. M. Marshall, Vicksburg, Miss.; James Orange, Hong-Kong, China; William A. Pike, Minneapolis, Minn.; T. M. Rood, Mechanicville, N. Y.; William L. Scaife, Pittsburgh, Pa.; George C. Smith, Montevideo, Uruguay; R. Watkins, Sydney, N. S. W.

*Juniors:* William H. Chadbourne, Chadbourn, N. C.; A. C. Stites, Kansas City, Mo.; C. Davis, C. H. Dean, New York City.

**Civil Engineering Society of the Massachusetts Institute of Technology.**—At the 21st regular meeting, in Boston, November 20, Mr. H. C. Bradley read a paper on the Erection of Iron Bridges, and C. W. Sherman one upon the Disposal of Sewage at Worcester, Mass. An informal discussion of the methods of disposing of sewage sludge, the propagation of disease germs through water, and the various uses of chemical filtration closed the meeting.

**New England Water-Works Association.**—At the quarterly meeting in Boston, December 10, President Noyes made a short address. Professor Niles then made an address on Climatic Variations in their Relations to Water Supply, which contained many interesting facts.

Mr. Desmond Fitzgerald gave some details of the new reservoirs at Covington, Ky. Mr. Solon Allis read a paper giving an account of the replacing of some cement-lined pipe at Malden, Mass., by cast-iron pipe. Several other members spoke of the replacing of the cement-lined pipe in different places.

**Connecticut Association of Civil Engineers & Surveyors.**—At a meeting held in East Berlin, Conn., November 29, E. O. Goss and W. E. Johnson were elected members.

The report on Dam Legislation prepared by a special committee, was discussed at some length. Mr. C. M. Jarvis made an address on Bridge Construction, and Mr. C. H. Bunce read a paper on Asphalt Pavements, which was discussed.

**Master Car-Builders' Association.**—The Committee on Air-Brake Standards has issued a circular containing the questions below, which members are asked to answer, sending their replies to the Chairman, Mr. John S. Lentz, at Packerton, Pa.

"How many freight equipment cars have you equipped with M. C. B. standard air-brake details, *practically* like those shown in Plate X, *Proceedings* 1890?

"How many of the same cars are equipped with iron brake-beams?

"How many freight equipment cars have you equipped with iron brake-beams, and with brake details different from those above mentioned?

"Do you think that good results can be had and maintained by any form of wooden brake-beam with modern air-brake equipment, or do you consider that iron brake-beams are necessary for good results and economy?"

**Engineers' Club of Philadelphia.**—At the regular meeting, November 15, Mr. Robert J. Parvin, at the hands of the Secretary, presented a handsome pointer to the Club, to be used in

explaining the large illustrations often presented at the meetings. It was received with a vote of thanks.

The Secretary called attention to the question of contributions to the Club subscription to the proposed Engineering Headquarters and Congress at the World's Fair in Chicago.

The Secretary presented, for Mr. R. Taylor Gleaves, a description of Continuous Rails for Railways, which are carried upon ordinary ties of wood or iron weighted down with a covering of earth, gravel or stone, so that they cannot easily move. The spikes are not driven home by three-eighths of an inch, so that undulations may take place in the rail without disturbing either spikes or ties, and arrangements resembling turnouts are put in at fixed points, such as frogs, and at the foot of heavy grades, for the purpose of admitting of longitudinal motion.

After some discussion of this paper the meeting adjourned to lunch.

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At the regular business meeting, December 6, a letter was presented from Captain S. C. McCorkle, accompanying the latest chart issued by the Coast Survey of Alaska, mentioning it in connection with the proposed railroad to Russia by way of Behring Straits.

It was ordered that a Committee of three be appointed to consider the best means of increasing interest in the Club and its meetings.

Mr. John E. Codman presented notes on the Rainfall in the Vicinity of Philadelphia in 1889, referring to the extraordinary storms of that year and giving a description of the automatic rain gauge used by the Philadelphia Water Department.

Mr. Strickland L. Kneass presented a paper on the Internal Condition of an Elastic Fluid During Discharge Through an Orifice. This paper described a number of experiments taken. These consisted of observations taken from a brass tube 0.3 in. in diameter, pierced by seven small holes. Upon these were placed pressure gauges, and the tension of the steam was obtained at seven different points of the tube; from this data was determined, and graphically shown, the velocity of the steam at every point of expansion between initial and terminal pressures.

The phenomena of discharge under some conditions were peculiar; one experiment showed an actual tension of the steam from 5 to 7 lbs. below atmospheric pressure, even though the tube was discharging freely into the air.

The paper closed with a description of a nozzle proportioned upon the theory of constant acceleration.

Mr. Wilfrid Lewis presented a description of a new Feed Ratchet invented by him.

**Engineers' Club of Cincinnati.**—At the November meeting of the Club there was an attendance of 29 members and several visitors.

One application for membership was received and three new members were elected: Messrs. H. C. Innes, H. E. Warrington and Percy Jones.

The paper for the evening, by Mr. John W. Hill, under the title of Some Remarks upon Water and Sewerage Works from a Sanitary Standpoint, treated at some length the important subjects of proper and sufficient water supply, drainage, and sewerage and garbage disposal.

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**Civil Engineers' Club of Cleveland.**—At the regular meeting, December 9, Professors Harry F. Reid, Boswell C. Miller, Arthur Skeels, and Messrs. David Owen and Boswell H. St. John were elected active members. Mr. King, of Norwalk, O., was invited to address the Club, and explained some of the methods used and discoveries he had made in pure mathematics. Then followed a discussion of the Injurious Effects of Cement on Lime Mortar, which was opened by Mr. C. O. Arey and participated in by Messrs. Richardson, Eisemann, and Hermann, who had noticed in buildings that lime mortar to which cement had been added was weaker and not as hard as that in which no cement had been used. Mr. Thompson had noticed that cement mortar had failed to produce a bond between limestones when the same mortar would form an excellent bond with sandstones. Mr. Morse had seen buildings taken down where first-rate results were shown with the cement lime mortar. The present practice among Cleveland architects appears to be to use clear cement mortar or clear lime mortar, except in freezing weather, when a little lime is added to cement mortar to prevent freezing before setting.

Professor C. L. Saunders then read an interesting paper on Transmission of Power by Belt and Rope, giving an account of the recent improvements of the various substitutes that are used instead of leather belts, the means taken to prevent slip, some of which are more than worthless, diminish friction, and never increase their efficiency and reduce the expense. This was followed by a discussion by Messrs. Mordecai, Roberts, Barber, Swasey, Eisemann, Bowler, Benjamine, and Hermann. Mr. Swasey mentioned a patent coupling which seems to be very efficient, and for turning anglers an excellent substitute for a twisted belt, but thinks that the day of the leather belt is by no means past. Mr. Benjamine stated that a crossed belt has but 90 per cent. of the efficiency of a straight one, with one turn only 80 per cent., and with one-quarter turn and a guide pulley less than 30 per cent. Messrs. Eisemann and Bowler mentioned cases where ropes had been discarded and belts substituted on account of expense. Mr. Hermann thought this was caused by a defect in design or workmanship. Mr. Roberts thought that with slow-moving belts the atmosphere had but little to do with slip and resistance, but since the advent of the dynamo and a belt-speed of over 6,000 ft. per minute this requires more study.

Perforated belts appear to have done good service, and boring holes through the pulleys seems to have been of great advantage.

Mr. Benjamine states that a belt with a velocity of over 6,000 ft. per minute requires the most careful balancing in all its parts to increase efficiency and prevent injury from its great centrifugal force.

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**Engineering Association of the Southwest.**—At the annual meeting in Nashville, Tenn., November 13, the Secretary, Professor O. H. Landreth, reported a total of 101 members of all classes. The total receipts were $602 and the balance on hand $377. Ten meetings were held during the year, and 10 papers were read.

The annual address of the retiring President, Mr. John McLeod, was read. It was a valuable and interesting summary of the general development of engineering during the year.

The following officers were elected for the ensuing year: President, John B. Atkinson; Vice-Presidents, William L. Dudley and Charles Hermany; Secretary, O. H. Landreth, Nashville, Tenn.; Treasurer, W. B. Ross.

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**Western Society of Engineers.**—At the regular meeting, in Chicago, December 3, reports were received from the committees on Annual Meeting and on Nomination of Officers.

Mr. Otis K. Stuart read a paper explaining the construction of De Bausset's Air Ship.

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**Engineers' Club of St. Louis.**—At the regular meeting, November 20th, Professor J. B. Johnson read a long paper on Aerial Navigation, which was briefly discussed by members present.

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At the annual meeting, December 3, the Secretary presented his report, showing a total of 179 members. There were 22 meetings held during the year, at which 22 papers were read. The Executive Committee presented a report showing total expenditures of $1,529, and giving an attractive programme of papers promised for the meetings of the year. The standing committees also presented their reports.

The Nominating Committee presented the following names for officers for the ensuing year: President, George Burnet; Vice-President, N. W. Eayrs; Secretary, Arthur Thacher; Treasurer, C. W. Melcher; Librarian, J. B. Johnson; Directors, F. E. Nipher and S. Bent Russell.

Mr. J. A. Seddon read a paper on Economic Dimensions of Settling Reservoirs, the discussion of which was adjourned to the January meeting.

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**Montana Society of Civil Engineers.**—At the regular meeting in Helena, Mon., November 15, Henry J. Horn, Jr., was elected a member. It was resolved to appoint a delegate to represent the Society on the General Committee to arrange for the International Engineering Congress in Chicago, in 1893.

A change in the time of meeting was discussed. Committees were appointed to arrange for the annual meeting to be held January 17, and to nominate officers for the ensuing year.

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**Northwestern Track & Bridge Association.**—At the regular meeting in St. Paul, November 14, there was a paper read on Pile and Trestle Bridges, by Mr. Amos. This was followed by an extended discussion, in which notes of practice on different roads were given.

Mr. McMillan read a paper on Discipline and Management of Trackmen, which was followed by a short discussion.

## NOTES AND NEWS.

**Railroad Gauges.**—The *Engineer* says that no less than 39 different railroad gauges seem to have been in use between 1880 and 1889.

**Old Rolling Stock for Sharp Curves.**—The accompanying illustrations, from the London *Engineer*, show one of the locomotives in use on the Paris-Sceaux-Limours Railroad, a suburban line 40 km. (24.86 miles) long. Fig. 2 is an inverted plan showing the radial arrangement adopted for the cars, and the method of coupling. The draft from the axles and not from the car body is somewhat similar in type to the device in use on the elevated roads in New York. The railroad is being reconstructed, and will hereafter be worked with rolling stock of the ordinary French type.

Constructed in 1848, the line was conceded to the Paris-Orleans Company in 1866, and this date, along with the name of M. M. V. Forquenot—late Chief Engineer of Traction of that company—is borne by the name plates of many of these engines. Being built at Ivry—the Paris shops of the Orleans line—these engines might be supposed to resemble the standard designs of that road; but, instead, they have remained differentiated distinctly in their characteristics from any regular French locomotives. The peculiarities of the Limours Railroad is that the gauge is 1.75 m. (5 ft. 8.8 in.). The terminal stations at Paris, Sceaux, and Limours are circular in form, the two tracks entering into a single loop of 81 ft. radius, making an endless railroad, and, in addition, between Bourg-la-Reine and Sceaux there exists an S curve along the ridge of a valley having one curve of the same radius.

Under these conditions, the rolling stock, which has been in use so many years, is also peculiar, and perhaps not readily understood when we think of the numerous radial contrivances in use to-day. The small cars are carried on four wheels, each axle being free to swivel around under a circular frame beneath the carriage body, an arrangement analogous to that of an ordinary road vehicle, but each axle-frame is connected by a central pole, and two diagonal rods from the periphery of each side of the leading frame cross to the opposite side of the next circular frame, by which means leading wheels, turning inward to the left, cause the following pair to turn equally outward to the right, and the long hallow bar attached to this last steers the first axle of the following vehicle in the same circular course—this pole being at once the coupler, draw-bar, and springless buffer. This axle radiating arrangement has been patented and repatented in England. Naturally there is no strain of traction whatever upon the car bodies themselves. For the engine the radial movement is of the same principle, but different in detail. In place of the swivel or locking carriage a section of a circle is fixed to the ends of the leading and trailing journals, and these curved brackets support the spring blocks above. Although free to turn within the radius allowed by the frame pivoted under the center of the engine frame, the trucks each carry a set of four guard wheels with beveled edges, which are mounted at an angle of about 25° with the inner edge of the rails, and really guide the bearing-wheels more than the flanges on the latter. The driving-wheel treads are without flanges, 11¾ in. on the face of the tire. To permit the necessary clearance required by the oblique guide-wheels the switch-points with butt ends have a clear displacement of about 5 in. However well this engine has been suited to the special requirements of the line—which has at least one gradient of 1 in 50—the cost of maintenance due to such curves, and the disadvantage of the gauge restricting intercommunication with other lines, have decided the engineers to adopt the standard gauge; the ordinary arrangement for terminal stations; the regular fixed-base four-wheel coach, and a rigid-wheel locomotive of special design more powerful than the present, and which should haul a greater number of coaches, since the new ones, it is said, will differ very little in weight from those now used—15,400 lbs. At present, the best time made between stations averages only 34 miles an hour, although 40 miles per hour are made occasionally. On the 25-meter curves the trains are regulated to nine miles, and on the longer deflections to 19 miles per hour, and on account of this low speed the super-elevation of the outer rail is really less than adopted for ordinary short curves. A full train consists of 15 cars, weighing about 100 tons without the locomotive.

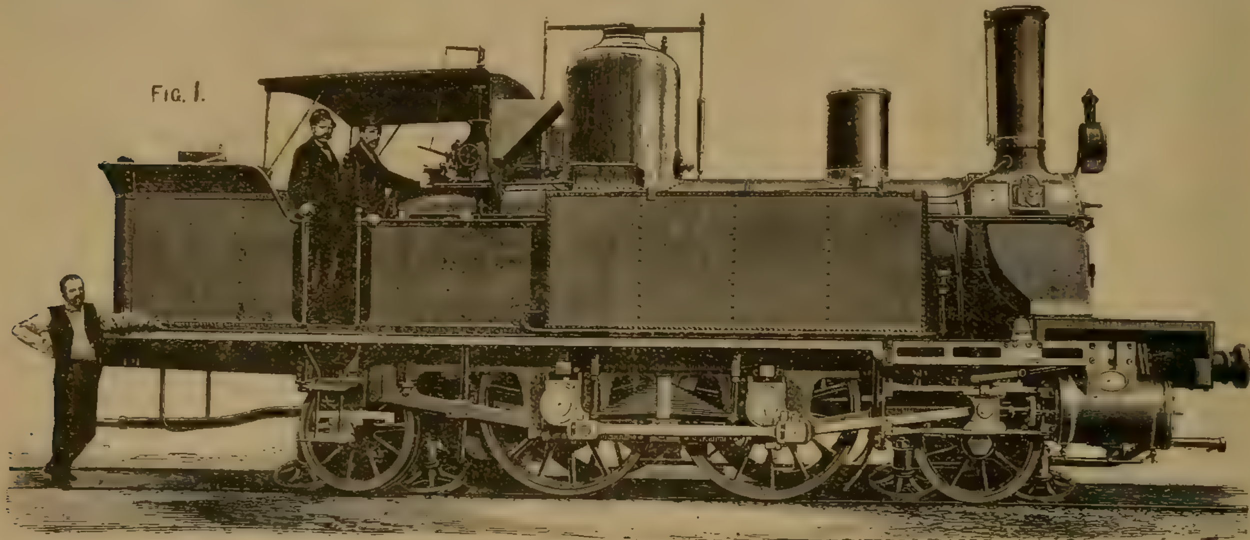


FIG. 1.

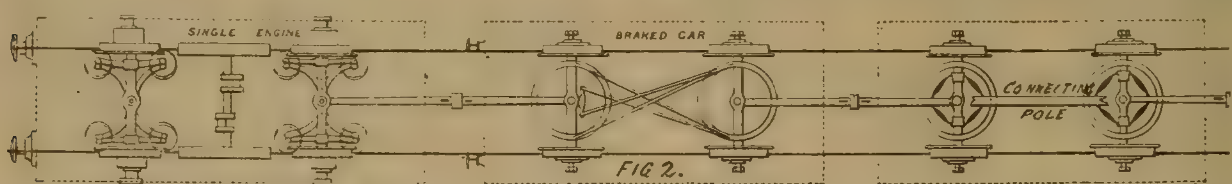



FIG 2.

**Brooklyn Bridge Traffic.**—In accordance with the yearly custom, a careful count of the passengers crossing the Brooklyn Bridge was made on Tuesday, November 25. The total number was 133,040, an increase of 13,212, or about 11 per cent., over the number on the counting day last year. The average was 5,543 per hour, but the distribution was very uneven, as might be supposed. The smallest number counted as crossing in an hour was 379, between 2 and 3 A.M.; the largest, 17,538 between 5 and 6 P.M. The larger number gives an average of 292 a minute, which gives some idea of the rush in busy hours.

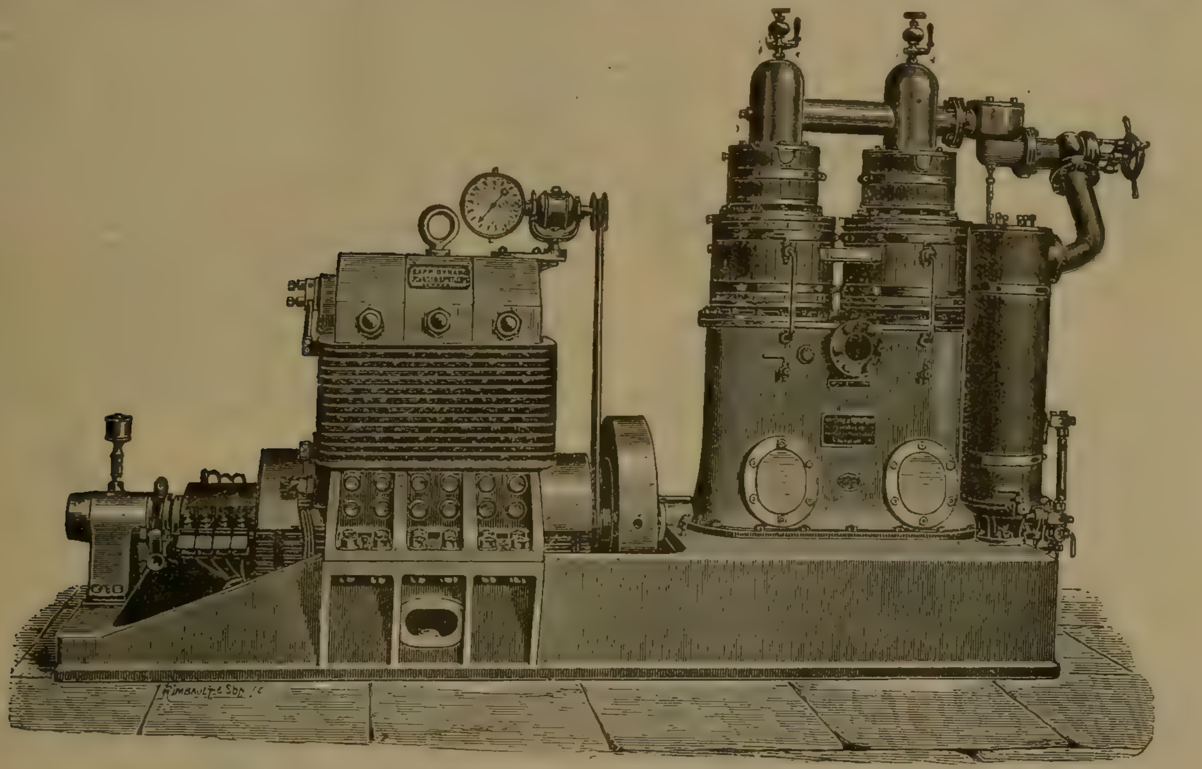
The number of vehicles also fluctuated very much, the smallest number in an hour being 23 between 1 and 2 A.M.; the largest 436—over 7 per minute—between 4 and 5 P.M.

**Combined Engine and Dynamo.**—The accompanying illustration shows a combined engine and dynamo, which is one of a set of three recently completed for the Birmingham Post Office. The engine is by Messrs. Willans & Robinson, Lim-

ited, of Thames Ditton, and is designed to develop 80 H.P. at 450 revolutions.

The dynamo is built by Messrs. Johnson & Phillips, of Union Court, London. The design is that of Mr. Gisbert Kapp. The output is 112 volts and 450 amperes at 450 revolutions per minute. The armature is of the drum type, the core being built up of iron disks. The end connections are arranged according to a patent of Mr. Kapp's. The connectors form a compact mass, which is put together independently, and then put on the armature like a commutator. The connectors are semicircular punchings of sheet copper, with a lug at each end. These lugs are bent right and left, forming when the connection is built up circular rows, to which the ends of the armature bars are attached. The field magnets have 15,400 ampere turns in the shunt, and 6,600 in the main; and about 1,094 watts in the two together. The armature is 15 in. in diameter, and has 102 external conductors, and full load loss of 1,095 watts.

Elaborate tests have been carried out to determine the efficiency of the combined set. The water used in one hour was 1,700 lbs.; the indicated horse-power, 79.7; and the electrical, 67.4. The efficiency of the combined sets is 84.6 per cent., and the electrical efficiency 96 per cent., the water consumption being 27 lbs. of steam per electrical horse-power hour.—*Industries.*



The Willans high-speed engine was described and illustrated in the JOURNAL for August, 1889, page 385.

**Re-afforestation of the French Alps.**—In a recent paper on this subject by M. L. Gonin, an engineer who has been engaged in the work, some interesting particulars are given. The fertile plains traversed by the Rhone, the Garonne, and their affluents, are frequently laid waste by the overflow of their waters. The magnitude of the inundations has been due principally to the increasing development of the torrents, especially those of the Alpine departments, caused by the destruction of the mountain forests and grass lands, and the disappearance of the vegetation by which the soil was protected, which, like a sponge, retained the rainfall, moderated the flow of the waters, reduced the floods, and acted as a protection against erosion of the soil.

As a remedy the torrents were to be arrested at their source; the materials removed by the waters were to be retained in the valleys or defiles; the formation of ridges and furrows, and the generation of new torrents in the bared places of the hills had to be opposed; vegetation had to be revived and protected from the sheep which find pasture in the mountains. To carry out these objects, two kinds of works were necessary: 1. The correction and regulation of the torrents by establishing a system of dams; 2. The replanting of the ground with wood and grass. The course of a torrent is divisible into three stages: the collecting basin, the outflow gorge and the settling bed in the form of a cone, in which the eroded matter brought down by the current is deposited. The valley of the Barcelonnette presents one of the most complete types of torrents. The Rion-Bourdoux dam is the most important of those in the valley. Its cone of deposit of the torrent covers an area of 600 acres—an area of desolation. The dam is 26½ ft. high above the bed, and has a width of 274 ft. The crown is 10½ ft. thick, and the wall slopes at the rate of 1 in 5 to the bottom. The foundations are 18¾ ft. thick and 14¾ ft. deep. The crown of the dam, in horizontal plan, forms a circular arc of 170½ ft. radius. In elevation it presents a level platform 65½ ft. long, joined to a circular arc at each end of 112 ft. radius, having a rise of 13 ft. at each end, and 52½ ft. long. They make a total width of 170½ ft., and are finished with an earth formation at each end. The dam is constructed entirely of hydraulic masonry in very large blocks. It is loop-holed by five openings near the bottom, and six smaller holes at a higher level, for the passage of water and liquid mud; but the lower openings alone are in operation, the upper ones being stopped up. They are fenced at the upper ends with cross bars of iron, the purpose of which is to obstruct the passage of stones, which are detained above the dam, and form a solid and resisting alluvion. An alluvion bed has been formed by deposition, reaching upward of 3,900 ft. above the dam, the surface of which is inclined at the rate of 1 in 9; this deposit constitutes a vast platform which lends itself to forest vegetation, and to the protection of the plantations established on the banks. Below the Rion-Bourdoux dam the correction is continued, comprising 10 dams and a rectification of the bed.

Besides the great Bourget and Rion-Bourdoux dams, there is a very large number of smaller ones. There are masonry weirs generally of the form of a circular arc in plan, crowned at the summit by a horizontal platform as wide as is practicable and finished at the ends with arcs of circles. The stream is thus spread out into a comparatively thin sheet, and the erosive force of the fall at the foot is minimized. These dams are increased in height from time to time in proportion as the deposit above accumulates. An opening is made through the wall near the base for the passage of water with solid matter in suspension.

For the smaller dams, owing to the want of stone, wood in the form of wattle fences and fascines is employed. According to one mode of construction two rows of stakes, in larch and willow, are planted across the bed of the torrent, with willow branches interlaced, forming the body of the structure. The stakes are bound together by a longitudinal timber laid horizontally a little below the level of the crown. Behind the dam, for its protection, a body of earth and small stones is placed.

It is planted with slips of trees, by the growth of which the consolidation of the work is promoted.

In the valley of the Barcelonnette there are nearly 3,000 dams, 71 being large structures and 2,916 small ones of wood. The total expenditure in this valley has been about $553,000, including general charges.

**A Clock Dial for 24-Hour Time.**—The accompanying engraving, from *Indian Engineering*, shows the standard dial for 24-hour clocks adopted by the Indian State Railroads. It will


be seen that only a minute hand is used on the face, the hour dial revolving inside, instead of being marked on the dial, so that the hour appears through the slot in the face. Thus the time indicated in the engraving is 23:24—that is, 11:24 P.M. in the ordinary notation.

Clocks of the pattern shown are to be supplied to all the Indian State Railroad offices, as fast as new time-pieces are required.

**Relative Corrosion of Iron and Steel in Salt Water.**—At a recent meeting of the British Institute of Marine Engineers, Mr. David Phillips stated that he had made experiments extending over seven years—from 1881 to 1888—with two pieces of Bessemer steel boiler plate, two of Yorkshire iron, and two of B. B. Staffordshire iron. All the plates were the same size, 6 in. × 6 in. and ⅜ in. thick, and all were kept immersed in salt water. The results showed a considerable difference in the loss by corrosion. During the first three years the plates were in contact, and the steel plates lost 120 per cent. more than the iron; during the second three years the plates were separated, and the steel lost 124 per cent. more than the iron. For the entire period of seven years the loss of the steel was 126 per cent. more than that of the iron plates.

**A Balloon Expedition to the North Pole.**—The *Revue Scientifique* (Paris) gives some details of an expedition to the North Pole which MM. Besançon and Hermite propose to make by balloon, in order to ascertain whether land, water or ice exists at the magnetic pole, and to obtain a collection of topographical photographs and a series of meteorological observations.

In 1870 and in 1874 MM. Sivel and Silbermann published some studies on the possibility of such a voyage, but MM. Besançon and Hermite now intend to reduce the matter from theory to practice, and have decided to build a balloon which will do the work. This balloon, which will be inflated with pure hydrogen, will have a capacity of 15,000 cubic meters (529,313 cub. ft.) and will be able to raise 16,500 kg. (36,366 lbs.). It will be composed of two thicknesses of China silk, and will be capable of resisting a pressure of 1,000 kg. The bag will be covered with a special varnish having a base of oil and collodion, which, it is believed, will make it absolutely impermeable to gas.

The travelers will carry with them four small pilot balloons having a capacity of 50 cub. m. (1,764 cub. ft.) each, which are to be set free above the pole to test the aerial currents; also four balloons, each of 350 cub. m. (12,350 cub. ft.) capacity, which will serve as reservoirs, to keep up the supply of gas in the large balloon. In order that the main balloon may not rise too high, and may be kept at a certain distance from the earth, to permit regular photographic observations, it will be provided with a heavy guide-rope, attached to the car, which will drag upon the ice or float on the water, and which, in case of excessive expansion of gas, will serve as a drag or moving anchor.

The car will be constructed of wicker-work protected by an outer shell of thin steel; it will be made so that it can be entirely closed, to protect the passengers from excessive cold. Besides the observers it will carry their instruments and provisions for a month, and also a life-boat of very light construction, a dog-sledge, and eight dogs, to provide for return in case of accident to the balloon. The expedition will cost about $110,000; it will be ready to start in 1892, and will occupy about six months.

**A Steam Wharf Crane.**—The accompanying illustration shows a 25-ton steam crane built by the firm of Shanks & Son, Arbroath, Scotland. It is used for loading vessels with coal in a way which will be easily understood from the illustration. When the loaded car has been run alongside the crane, it is hoisted up in a cage or cradle, as shown, the wheels being secured by folding up the end pieces of rail attached to the cradle, which are jointed for the purpose. It is then swung round to the quay, and lowered to the desired position over the ship's hatchway, when by means of a simple and efficient arrangement with which the crane is provided, the truck is tilted up, and its contents emptied into the hold. The truck with the cage is then swung round, the latter dropped into its position, the empty truck run off, and its place quickly taken by another, when the operations are repeated. A cargo of 1,000 tons of coal can thus be shipped in about 10 hours. With this arrangement of cage a turntable is unnecessary, and its cost is saved, the crane being in this respect unlike others used for a similar purpose. The jib of this crane is of steel, and has a radius of 25 ft. The crane post is also of steel, and of ample strength. The heaving gear, which consists of single and double purchase motions, with the necessary levers, is driven by a pair of engines, each of which is provided with a set of case-hardened link-motion reversing-gear. The slewing gear (which is quite independent of the heaving gear) also consists of a pair of engines. The speed of lifting, in double gear,

is 20 ft., and in single gear, 40 ft. per minute, and that of slewing 70 ft. per minute; but all may be varied as desired. The plan of having separate engines for the lifting and slewing motions is adopted to obviate the necessity for using engaging and disengaging clutches, the latter arrangement being not only hard work for the operator of the crane, but also dangerous when heavy weights are being lifted. The boiler, which is of the vertical type, is of ample power. The crane is provided with a sheet-iron house, having a glass front, as shown in our illustration, affording protection from wet weather to both the workman and machinery.—*Iron.*

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NEW YORK, FEBRUARY, 1891.

THERE is to be held at Prague, in Bohemia, beginning in May next, an exhibition which will mark the centennial of what, it is claimed, was the first trades exhibition ever held in Europe, which took place at Prague in 1791. It will last from May to October 15, and American inventors are especially requested to contribute devices for the prevention of accidents in industrial works, and inventions of a similar class.

THE engineer who has run a line through the mountains of Colorado or the forests of Maine or Michigan has doubtless had his trials and hard experiences, but it may be a question whether his work was really harder than that of a party of surveyors who were recently observed taking levels and measurements along lower Broadway in New York during the busiest hours of the day. Natural obstructions presented by mountain and forest can be overcome by perseverance, but to sight a transit or use a tape-line in the throng of vehicles and foot passengers which filled the street required a degree of patience and care which certainly deserve mention at least, if not reward.

IT is announced that a contract has been concluded under which the Baltimore & Ohio Railroad is to send freight to New England by way of the Poughkeepsie Bridge. The connection with the bridge is to be made over the Philadelphia & Reading tracks from Philadelphia to Slatington, Pa., and thence over the Pennsylvania, Poughkeepsie & Boston Railroad.

The Baltimore & Ohio has never had a very large share of New England traffic, which has gone mainly by the more northern trunk lines. Such freight business as it has had to and from that section has heretofore gone by way of New York. With the new connection its share may increase, and, at any rate, it will probably be large enough to make a welcome addition to the business and revenues of the bridge and the railroads which cross it.

THE season of navigation on the Erie Canal closed early in December, and on the lakes about the middle of the month. A repetition of the very mild and open winter of 1889–90 was hardly to be expected, and there is every indication of a more severe season than has been seen for several years past.

During the season of navigation now closed the freight business done on the lakes and canals has been very large, but vessel and boat owners claim that it has not been profitable for them, chiefly on account of the competition caused by the great increase in the number and tonnage of vessels. There is considerable truth in this, without doubt; but the business is still profitable enough to cause the building of a number of new vessels, though there is some falling off from the construction of recent years.

THE probabilities seem to be that there will be no National legislation on irrigation by the present Congress. In the long session so much time was taken up by political legislation and party struggles that the subject was passed by almost entirely, and the present session will be too short to give any opportunity for action. Some legislation is needed, and too long a postponement may cause trouble in the future. The new Congress will be so different a body from the present one, and will contain so many new members, that it is not easy to predict what sort of action it may take on the Irrigation question, or whether that subject will be neglected entirely.

THE permanence of the supply of natural gas is an important question in some parts of the country. Scientists differ very much in their opinions, and only experience can decide. In Pittsburgh recently there has been a deficiency in the supply, and many factories have been obliged to go back to coal, at considerable trouble and expense to themselves. In Ohio and Indiana also it is reported that a decrease in pressure has been observed at some of the gas-wells, and the supply is diminishing. This will cause some local disturbance, but the coal operators will be inclined to accept the situation philosophically.

THE reports from the Nicaragua Canal are favorable. Much progress has been made in the preliminary work of clearing and preparing to begin the work of excavating the canal. The railroad which is to run alongside of the canal line to facilitate the work is well advanced toward completion, and the improvement of the harbor at the Atlantic end of the canal is in progress. Several of the large dredges which were in use on the Panama Canal have been secured and brought up to Greytown, where they will soon be at work excavating. Everything will soon be in readiness for the actual work of excavating the canal itself.

The preliminary works are considerable in extent and importance, so that a substantial advance has been made already, while the prospects for the future are encouraging.

IN a recent article in the *Revue Scientifique* Mr. Daniel Bellet calls attention to the number of projects for ship canals which are now attracting attention in Europe. Those actually under construction include the Corinth Canal, the Manchester Canal, the Baltic-North Sea Canal and the improvement and canalization of the Loire, which will enable sea-going vessels to ascend that river to Nantes.

Among projects which have not yet reached the stage of actual work are the canals to Paris and to Berlin, both of

which have been referred to in our columns; the Forth & Clyde Canal in Scotland and the Escaut Canal in Belgium, which is to make Brussels accessible to large vessels. Other plans, which must be considered as entirely on paper as yet, not having reached even the stage of survey and location, are for a canal across Southern France from Bordeaux to Narbonne, to connect the Atlantic and the Mediterranean; a connection between the Black Sea and the Caspian; the White Sea Canal in Russia and the canalization of the Tiber up to Rome. All of these have their earnest advocates among the engineers of the countries in which they are planned.

It may be noted here, as a curious illustration of French feeling in the matter, that a writer so well known as M. Bellet refers to the Panama Canal as the next great interoceanic connection which will follow the Suez Canal, and adds: "We do not know that it is necessary to consider as serious the project of an interoceanic canal by way of Lake Nicaragua."

To us on this side of the water this looks like a deliberate reversal of the actual state of facts, but in France it seems that there is a large majority which still looks upon the Panama Canal as certain of completion, and refuses to recognize that substantial progress has been made on the Nicaragua Canal.

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THE new railroad mileage built in the United States in 1890, according to the figures collected by the *Railway Age*, amounted to 6,080 miles, which is 850 miles more than was reported in 1889. While the year was not an unusual one in point of railroad construction, it was fully up to, and in fact rather over the average, which for the past 20 years has been 5,700 miles yearly. Indeed, it has never been exceeded largely except in the three years 1880, 1883 and 1888.

About one-third of the new mileage reported was in the South Atlantic and Gulf States, where 2,006 miles are reported; one-sixth was in the Southwestern States, including New Mexico and Arizona, and another sixth, 1,047 miles, in the Northwestern States beyond the Mississippi, the latter being chiefly accounted for by the large additions made to the mileage of the Northern Pacific and the Great Northern Roads. The Pacific Coast States make a fair showing with 624 miles, more than half of which was in Washington, while the building in the Central States, from Ohio to Wisconsin, furnished 802 miles. The large increase made in the South is in continuation of the work of the preceding two years, in both of which that section showed a greater increase than in any other part of the country.

The 6,080 miles reported were on 337 different lines, giving an average for each one of only 18 miles, and showing that a very large proportion of the railroad building done in 1890 was on short lines and branches of existing roads. To only three lines, in fact, was the addition more than 100 miles, and only a few others report over 50.

The leading State in new mileage was Montana, in which there is plenty of room for railroads, and in which 421 miles were built, the State profiting largely by the rivalry between the Great Northern and the Northern Pacific. The other States reporting large increase are Georgia, 375 miles; Washington, 341 miles; North Carolina, 309; Texas, 253; Alabama, 253; Pennsylvania, 252; Virginia, 228; Ohio, 223; Kentucky, 22; Nebraska, 218; Colorado, 211 miles. The States showing the least mileage are Iowa and Nevada, each reporting a single mile.

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THE New York Aqueduct Commission has approved the report of its Construction Committee, recommending that steps be taken at once to build the new Croton Dam on the site recommended by the Chief Engineer Fteley. Mr. Fteley's plan, as we have heretofore noted, provided for the abandonment of the proposed great masonry dam at Quaker Bridge and the erection of a smaller dam at a point a short distance below the old Croton Dam, which would furnish storage capacity enough for a number of years to come, and could be built at a very much less cost than the Quaker Bridge Dam.

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THE latest rapid transit plan for New York City has been presented by Mr. Austin Corbin, who proposes to build a tunnel from 50 to 60 ft. below the surface, starting from the Battery, running under Broadway and the Boulevard, under the Harlem and as far north as Van Cortlandt Park, near the northern limit of the city. It will then turn eastward to Fordham and south along Third Avenue to Union Square, where it will rejoin the line from the Battery. Two loops or branches are also proposed, one from the Battery up the west side of the city, near the Hudson River, to the main line near Forty-second Street; the other from the Battery up the east side to the Third Avenue line at a convenient point. In connection with this line it is proposed also to build a tunnel under the East River to Brooklyn and one under the Hudson to Jersey City, connecting with the railroad stations there.

A deep tunnel will cost more to build than a viaduct or elevated railroad, but, on the other hand, it will not require the enormous expenditures for right-of-way and damages to adjoining property which are inevitable with a line on the surface. As an engineering work the tunnel is entirely practicable.

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IT is proposed to hold a celebration in Washington in April next to commemorate the end of the first and the beginning of the second century of the American Patent System, the first patent having been issued in April, 1791. There has been formed a Central Executive Committee with an Advisory Committee, including a number of distinguished names, and it is hoped that the movement will be seconded by the inventors of the country and others interested in such a way that the event will be celebrated in a fitting manner. All who desire to take part or assist can secure information by writing to the Secretary of the Executive Committee, Mr. J. Elfreth Watkins, whose address is at the United States National Museum, Washington.

In this connection it is proposed to organize a national association of inventors, the Centennial Anniversary being considered an excellent time for such a purpose.

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THE Navy Appropriation Bill, as reported by the House Committee in Washington, makes provision for only one new vessel, and that is a triple-screw protected cruiser of 7,350 tons displacement, to cost $2,750,000 without armament. This vessel presumably is to be a companion to Cruiser No. 12. The bill provides for an appropriation of $960,000 for the equipment of new ships and $4,000,000 for their armament. The amount provided for the con-

struction of ships and machinery already authorized is $11,607,000.

A provision in the bill, as reported, allows the Secretary to use $100,000 of the amount appropriated at the last session for nickel ore to make tests in the development of American made armor-plates. An interesting item in the bill provides $25,000 for equipment and arms for naval militia in the various States, this allowing the Secretary to provide for the naval reserve.

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THE last Board of Experts which has been considering the question of the Brooklyn Bridge traffic has made a report recommending a plan for the arrangement of the terminals, so as to increase the capacity of the bridge railroad. The experts consider that the use of the loop or continuous track system for the New York terminal is rendered impossible on account of the enormous cost of obtaining sufficient real estate, and their plan is substantially for the enlargement of the present system, providing additional platforms and additional switching tracks, so that the number of trains may be increased. The experts believe that with these arrangements the headway between these trains can be reduced to 45 seconds, increasing the capacity of the railroad, with four-car trains, from 16,000 to 32,000 passengers per hour. This, they think, will be sufficient to provide for the traffic for some years to come. It is not understood that they recommend this as the best possible arrangement, but only as the best attainable under existing circumstances.

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## THE DISCOMFORTS OF RAILROAD TRAVEL.

IN an admirable essay on Organization in Daily Life, the Author, Sir Arthur Helps, said:

> If you want to improve the administration of railways, I will tell you how to do it. Look out for a very ingenious, sickly man, with a large family, and give him £4,000 a year as an inspector of railways. Let him make short reports, in good English, of his sufferings on the different railways, specifying names, dates and every particular. He must be bound to travel occasionally with his whole family, in the depth of winter. We do not know of their sufferings sufficiently in detail. An ordinary person would be ashamed to describe these minutiæ; but it must be this man's business. Besides, seriously speaking, he would meet with great differences of treatment. One thing is well managed on this railway, another on that. He would be able to praise as well as to blame. There is one railway I know of on which, to my judgment, the coupling of the carriages is not sufficiently attended to. There is another railway on which I have never found the same fault. My inspector would tell the world these things, and an effect would be produced upon the traffic of these lines.

Probably few of the subscribers of this JOURNAL will read the above suggestion without feeling a desire to be appointed such an inspector, not alone for the salary of £4,000, but from a sort of instinct of reform which most active-minded people feel, and which manifests itself in a longing to set those things right which, in their judgments, are going wrong. While such an appointment and salary would not be easy to get, any of us may indulge in the hypothetical exercise of the duties and privileges of the office—without the salary. The writer has a sufficient amount of overweening vanity to imagine that he has some of the qualifications required of such an inspector. He is sufficiently ingenious to be called a "crank," and though not exactly sickly, he has a digestive apparatus which does not consume its fuel as successfully as a locomotive with a brick-arch does. He has not a large family, but he nurtures a brood of cares, anxieties, duties and responsibilities which he takes with him in his travels and which are perhaps as troublesome as a family would be. He can make a report in English which competent critics would reject as a model of style, but it has the merit of being comprehensible. He therefore assumes the office of a self-appointed inspector of railroads, and submits this his

### FIRST REPORT.

Those of us who have passed the semi-centennial divide, which separates the ascent from the descent of life, can remember when few other luxuries were provided for railroad travelers excepting peanuts and ham sandwiches. At that time any distinction of classes or persons when traveling, or in the accommodations afforded them, was regarded with disfavor. Foreign immigration and other causes has since then made such a distinction desirable to those whose person, clothes, and language are clean; and prosperity has enabled many of our countrymen, and not a few of the immigrants, to pay for exclusiveness, comfort, and luxury. These causes have created the demand which enterprising companies have supplied, and now on nearly all first-class railroads some kinds of cars are run on both day and night express trains which are intended to give some degree of exclusiveness and more comfort and luxury than is afforded by ordinary cars to those who want it, and are willing and able to pay for it. As remarked, such cars are intended to be more comfortable, more luxurious, and to give more protection from the aggressiveness of disagreeable people than the other cars are or do, and for such accommodations many travelers are ready and willing to pay an extra charge. The traveler pays so much money for an expected amount of gratification. The bargain is therefore a fit subject for criticism, if he does not get full value for the charge imposed, or if the accommodations furnished him are attended with annoyances which disturb his serenity or defeat the object for which he has expended his money. To show that there are some such disturbances is the object of this report, in which day travel will be considered first.

It may be said of this, with little risk of contradiction, that one of the chief reasons which leads many persons to travel is the pleasure of looking on new scenes or of "seeing the country." This is especially the case in those sections where the scenery is attractive, but even in other regions the constant variety and succession of scene is diverting and supplies a quiet sort of entertainment, which requires no active mental effort to enjoy, and is consequently very restful and recuperates the tired mind and body to a wonderful degree.

If, then, seeing the country is one of the chief objects for which many persons travel, and is a great pleasure to all, it would seem that to lose sight of that object in designing cars, and to arrange them so that it is difficult and uncomfortable to see the passing landscape from them, is almost as senseless as any act of human unwisdom could be. Nevertheless in arranging the windows and seats of many drawing-room cars apparently no thought has been given to the convenience or comfort of the passengers in seeing out of them. Such cars are often so constructed that passengers are unable to see out of the windows without either riding backward, or craning their necks, or doing both in a most uncomfortable and annoying way. Apparently the cars have been constructed and the windows arranged without any reference whatever to the seats, or, in other words, the cars are built first and

the seats are arranged afterward in the best way that is then possible. When the windows are very wide, as they are in some such cars, not only must every alternate passenger ride backward, but in some of them every third passenger has a panel alongside of his or her chair, so that it is difficult to see out of the car in riding either backward or forward. The arrangement seems to be especially designed for shutting out the view of the country through which the passenger is traveling. The persons responsible for such plans should be obliged to travel blindfold, and not be permitted to design or sanction the design of any new cars until they had learned enough mechanical drawing to be able to lay out a plan of a car showing the seats arranged in some sort of reasonable relation to the windows.

The reason for using the large windows in drawing-room cars is inscrutable, and eludes the most thorough investigation of common sense. They are inconvenient to raise and lower, are more expensive, and do not serve the purpose of seeing out of—which is the main purpose of windows—as well as those of ordinary size do. The sole object in using them seems to be that which induces so many architects to make the interiors of houses inconvenient and uncomfortable—that is, to make them look well from the outside. Windows in cars are like wives and tooth-brushes, each man should have exclusively his own.

The most distinctly luxurious appliances which have been adopted recently on cars are vestibules. For these it is claimed that they give a clear passage-way from one end of the train to the other, and that persons passing from one car to another are not in danger of falling off the platforms nor exposed to the weather, and that in addition thereto the vestibules increase the strength of cars very materially to resist collisions.

The complaint has however been made that they conduct the impure air from the front cars to those behind them, and prevent the admission of fresh air between them. The complaint is therefore very common that vestibule trains are badly ventilated. A little of the writer's experience some months ago will illustrate this. In a journey from Baltimore to New York he happened to take a train "bearing this strange device" *F. F. V. Limited*, the cars of which were all vestibuled. The train seemed to be supplied with every luxury excepting fresh air. The atmosphere inside the cars at Baltimore was vile. After leaving there it continued to grow viler and more villainous, and odors rank of boiled chicken, ham sandwiches, sulphuretted hydrogen, personal exhalations and atmospheric sewage were commingled in a nauseating mixture. At Philadelphia it seemed as though the atmosphere would no longer support combustion or life, and some of the passengers were compelled to go out into the fresh air or incur the danger of fainting away. The meaning of the "strange device" referred to has been deciphered in different ways, but the writer is convinced that F. F. V. means *Fright-fully Ventilated*. For this ventilation, or rather the want of it, the vestibules were in great measure responsible. When these are not used a little fresh air must come in when the doors are opened, or it can be admitted to better advantage by suitable ventilators at the ends of the cars than anywhere else. With the vestibules this supply is excluded, and instead the first car furnishes air to the second which has undergone one degree of vitiation; from the second it passes to the third with two degrees of contamination, and from the third it escapes to the fourth with three degrees of pollution, until in the last car it is only fit for railroad directors and superintendents to breathe. If we must have vestibules, give us decent ventilation. To have that there must be some adequate provision for the admission of a constant supply of fresh air. This provision has not been made in vestibuled trains, and the ventilation in many of them is execrably bad.

Considering the importance of ventilation in cars and how much has been said and written about it, it seems remarkable that so little has been accomplished to improve it. When mankind fall into error it is because they either believe something which is not true or do not believe something which is true. Now in car ventilation the true thing that is not believed is *the absolute need of furnishing an adequate supply of fresh air to keep the atmosphere in a car pure.*

The average car-builder and architect will always assume that by simply making a number of holes in the top of a car or apartment that the bad air will escape, but he never seems to inquire how the fresh air, which must take its place, will get in. We remember once seeing the principle of ventilation illustrated very forcibly in a car-shop. It was found that newly varnished blinds for car windows would not dry unless a certain amount of warmth was supplied. A close apartment or drying chamber was then constructed, which was warmed with steam-pipes. In it the drying proceeded to a certain extent and then stopped. Investigation showed that the air in the chamber absorbed a certain quantity of the volatile constituents of the varnish, but would take up no more than a given amount. If the air which was thus charged was removed and a fresh supply was furnished the drying continued, which led to a system of ventilation by a fan, which forced air into the chamber, and that which had absorbed some of the component parts of the varnish escaped through suitable openings. Simply adding ventilators for the escape of vitiated air was not sufficient. A constant and certain quantity of that which was fresh had to be admitted to the drying chamber. The same principle applies to car ventilation. *There must be an adequate supply of fresh air to keep the atmosphere in a car pure.* Such a supply is not ordinarily furnished on the vestibule trains.

Another very common evil in drawing-room and sleeping cars is the location and arrangement of the smoking-rooms. It is rare when one of these is at the front end of a car that the latter is not pervaded with the disagreeable odor of stale tobacco smoke. Either the smoking-room should be entirely excluded from such cars or some better arrangement should be devised for keeping the smoke out of the rest of the car.

Further criticism must be reserved for a future report.

## THE RULO BRIDGE.

THE RULO BRIDGE: *A Report to Charles E. Perkins, President of the Chicago, Burlington & Quincy Railroad;* by George S. Morison, Chief Engineer of the Rulo Bridge.

The title of this book indicates its purpose without further explanation. It is a volume of 70 pages which measure $21\frac{1}{4} \times 13\frac{3}{4}$ inches. The bridge described carries part of the Chicago, Burlington & Quincy system across the Missouri River at Rulo, which is located in the southeastern corner of

Nebraska, near the point where that State, Kansas and Missouri unite.

The Report of Mr. Morison gives first a history of the bridge, which is followed by a general description, from which the following extract is taken :

The Rulo Bridge is a single-track railroad bridge. It consists of three channel spans each 375 ft. long between centers of end pins, resting on four piers of granite masonry, at each end of which are three 125-ft. deck spans, being separated by iron towers 25 ft. long, making the length of the iron structure at each end of the channel spans 425 ft. . . . . The entire length of the whole structure from end to end of iron or steel work is 1,993 ft. . . . . The substructure comprises the four granite piers which support the channel span and sixteen small cylindrical piers which support the towers which carry the deck spans. These four piers are built on pneumatic caissons.

| | | | |
|---|---|---|---|
| Pier I. is 53 ft. long, | 25 ft. wide and | 18 ft. high. |
| " II. " 55 " | 27 " " | 18 " |
| " III. " 55 " | 27 " " | 18 " |
| " IV. " 53 " | 25 " " | 30 " |

Full information of the sinking of these foundations, and elaborate tables of their cost and that of the masonry, are given. The cost, including freight on materials, for the four piers and their foundations was as follows :

| | |
|---|---|
| Foundations | $220,742.75 |
| Masonry | 121,274 62 |
| Total | $342,017.37 |

Average cost of masonry per yard, $30.49.

The superstructure consists of three through spans and six deck spans, three at each end. Each through span is 375 ft. long between centers of end pins, 50 ft. deep and 22 ft. between centers of trusses. Expansion is provided at the west end of every span—that is, at the upper end—the bridge being on a grade.

Each deck span is 125 ft. long between centers of end pins, 17 ft. 6 in. deep, the trusses placed 12 ft. between centers. The spans are separated by iron towers 25 ft. long, thus making each set of deck spans with intermediate towers a continuous structure 425 ft. long, divided into 17 equal panels of 25 ft. each.

The total cost of the bridge was $1,020,384.75.

Specifications for the masonry, daily record of progress in sinking caissons, time, cost and materials used in foundations, and specifications for superstructure are given in full. This descriptive matter is followed by a full-page map showing the location of the bridge ; a general elevation, plan, profile and alignment of it ; a profile of stratification on bridge line ; five full-page lithographs showing the design and construction of the caissons and piers ; a diagram showing rate of progress in sinking caissons and another showing record of water-stage of the Missouri River during the construction of the bridge. These are followed by detailed illustrations showing the clay hoist used in laying the foundations, and a full-page lithograph showing the approach piers. Ten full-page illustrations are given representing the construction of the superstructure, and the interesting volume concludes with a map and section of a dyke which was built to protect part of the structure.

The printing, paper and illustrations are admirable, and altogether the volume is a model for reports of this kind.

## NEW PUBLICATIONS.

CHALLEN'S ENGINEERS' LOG BOOK. *Daily Runs for the Year.* (New York ; Howard Challen. Price, 75 cents and $1.)

CHALLEN'S ENGINEERS' DAILY REPORT. (New York ; Howard Challen.)

Every one who has run an engine, whether stationary or marine, knows the convenience and importance of keeping a record of the performance of his engine from day to day, so that he can refer back and see how it has run at different times and under different circumstances. Such a record not only gives him a means of making useful comparisons, but will serve to show whether his engine is doing the work it ought to, and whether the methods which he is following are the best and most economical. The Log Book, which Mr. Challen has prepared and presented seems to fill all the requisites of this kind. It has, in a size convenient to carry in the pocket if necessary, or to keep in any handy receptacle about the engine-room, a page for every week in the year, each page being ruled for seven days. The headings in the table give, besides the date, the Average Pressure, per gauge ; Hours Run ; Revolutions ; Vacuum, per gauge ; Piston Speed, in feet per minute ; Indicated H.P.; Initial Pressure, per indicator ; Terminal Pressure ; Temperature of Hot Well ; Temperature of Heater ; Water per H.P., in pounds ; Fuel Burned, in pounds ; Ashes ; Oil Used ; Waste Used. One blank column is left, and the page facing the table is also left blank in order that any remarks as to special conditions, etc., may be entered. With this book the engineer can make up his record in a few minutes each day and with very little trouble to himself. The headings seem to cover everything that is necessary, and a reference to any preceding page will at once give a comparison between the performance of the engine on any two given days, weeks, or other periods of time which may be chosen. The book is so arranged with blank dates that the record may be begun at any time during the year. It is at once a saving arrangement and a diary which ought to be a necessity to every careful engineer.

The Daily Report is a somewhat similar blank, but is made in pad form, so that it can be filled out, torn off and handed to the proper person. It is arranged to take in one day only, but has blanks for six engines on each sheet, so that if more than one engine is employed separate entries can be made for each. The headings on this report are : Time of Start ; Time of Stop ; Hours Run ; Revolutions ; Vacuum ; Receiver Pressure ; Indicated H.P.; Temperature of Room (four times daily) ; Temperature of Water (four times daily) ; Water per H.P., in pounds ; Fuel Burned, in pounds ; Ashes ; Engine Oil Used ; Cylinder Oil Used ; Waste Used. Where a report of this kind is required from the engineer this blank seems to cover all necessary points.

PHOTOGRAPHIC MOSAICS. *An Annual Record of Photographic Progress :* Edited by Edward L. Wilson. (New York ; Edward L. Wilson. Price, paper, 50 cents ; cloth, $1.)

Interest in photography is no longer confined to a few professionals. The use of the camera has become so common that any work of this kind should command a large number of readers. Engineers should perhaps be considered more than amateurs, since many of them find the camera not merely an amusement but a very useful assistant in their work. Mr. Wilson's Annual is a collection of short chapters showing the progress made in photography during the year, giving notes of new methods, hints to beginners, and other useful matters. How much is to be said on this subject is shown by the fact that the Annual contains 288 solidly printed pages, about one-third of which are occupied by the Editor's account of the progress of the year, the remainder being filled up by short chapters by different authors, both amateur and professional, on a great variety of subjects. The beginner will find here much matter to help him over his difficulties, while the expert will doubtless gather many useful hints.

ALMANACH DER KRIEGS-FLOTTEN (*Naval Almanac*), 1891. Prepared by the Editors of the *Mittheilungen aus dem Gebiete des Seewesens* (Vienna ; Gerold & Company).

As in previous issues, this little book is a storehouse of condensed information, and it is really difficult to see how more facts in relation to the navies of the world could be packed into the same space. We find in it a number of tables useful to naval officers and engineers ; a brief account of the artillery

adopted by different nations; a navy list for all the nations of the world; and 134 sketches or diagrams of armored ships, showing the leading types thus far brought into use.

The United States does not fill a very large space in the lists, but it is gradually growing, and we find that all our ships, whether completed or under construction, are carefully recorded, with brief descriptions of their general character. In the sketches we are represented by the *Maine*, the *Texas*, the *Puritan*, the *Terror* and the three new battle-ships.

Judging from the examinations and comparisons which we have been able to make, the work on this book has been most carefully and thoroughly done, and it will certainly be a most useful companion to a naval officer.

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First Lessons in Metal Working: by Alfred G. Compton, Professor of Applied Mathematics in the College of the City of New York. (New York; John Wiley & Sons. Price, $1.50.)

This book has been prepared by Professor Compton with the purpose of making it what its title indicates, and in making it he has been guided by his experience while in charge of the workshops attached to the City College and the course in the Manual Labor Department of that institution. The different chapters, or lessons, as they are called, are on Metal Working Tools for Wrought and Cast Iron; the Different Processes in Blacksmithing; Foundry Work; the Properties of Wrought Iron and Steel; the Methods of Working Steel; Chipping, Drilling, Filing and Soldering Metal. The Author's purpose and methods in making up the book can perhaps best be explained from an extract from his preface:

The first year of instruction in handicraft, as experience in the College of the City of New York has shown, may be given to wood-working or metal-working with about equal advantage. The minute accuracy, the acquaintance with geometrical construction, and the habits of neatness and cleanliness which are essential in the one, are offset by the judgment, forethought, and artistic freedom of the other. Both constantly teach the lesson of orderly procedure, careful attention to instructions, and, where a text-book is used, of minute and thoughtful reading, such as takes in the full significance of every proposition and every limitation of it. The feeling of good fellowship which results from struggling with the same difficulties, and occasionally, as in wood-working, and still more frequently, as in forge-work, lending a helping hand to each other, is a valuable part of the product of workshop training in either department. It has been the Author's practice therefore, for some time, to let a portion of each class begin in the wood-working shop, and another in the forge and vise-room. The advantage is thus secured of having both shops well filled; while otherwise, as the second year's class is always smaller than the first, one shop is overcrowded at the same time that the other is perhaps not more than half full.

The book being intended more for those who are acquiring a general education than for those who are learning a special trade, more time and space have been given to the development of the processes of manufacture of metal in their proper order than to the details of special work. As an assistant in a course of this kind it seems to be an excellent handbook for the student.

## TRADE CATALOGUES.

*Catalogue: Frogs, Switches, Crossings, etc. The Weir Frog Company, Cincinnati, Ohio.*

In the preface the Weir Frog Company announces that the present is its first catalogue, as its custom heretofore has been to send blue-prints, photographs, etc., as occasion required. The excellence of the book, therefore, must be the result of good judgment rather than of experience, for from almost every point of view it is a very good one. In the first place, it is well printed and of convenient size, with a page still large enough not to cramp the engravings. The illustrations are clear and good, and the descriptions are generally condensed, but yet sufficient to give, in connection with the drawings, a clear idea of the different devices. There is hardly a line of superfluous matter in the book, which must be considered very high praise.

The catalogue shows a number of patterns of switches and fittings; of frogs and of crossings, the latter including crossings of street as well as of steam railroads, and one pattern which is entirely new, a crossing of a steam railroad and a cable railroad, where some ingenuity is required to carry the rails over the cable conduit without interference.

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*The Pintsch System of Car Lighting by Compressed Oil Gas: the Safety Car Heating and Lighting Company, New York.*

This pamphlet consists chiefly of a list of the roads on which the Pintsch system of lighting cars has been adopted, and of letters from officers of some of those roads, testifying to its success.

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*Trinidad Asphalt Street Pavement; The Warren-Scharff Asphalt Paving Company, New York.*

The use of asphalt for street pavements is gradually increasing, and some information about the subject will be welcome to many who are interested in the paving question. This information is given in the four pamphlets issued by the company named above and included in the general title. Perhaps it would have been better if a little less space had been given to the description of the source from which the material is obtained, and a little more had been said of the behavior of the pavement under wear. No one doubts that asphalt pavement has many excellent qualities, and the main question has been as to its ability to stand under heavy traffic. Some particulars on this point are given, it is true, but more would be desirable.

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*Catalogue of Injectors, Steam and Check Valves, etc.; Rue Manufacturing Company, Philadelphia.*

*Joy's Valve Gear; Illustrated Circular: David Joy, London, England.*

*The Roney Mechanical Stoker and Smokeless Furnaces: Illustrated Description. New York; Westinghouse, Church, Kerr & Company, Engineers.*

*Open-hearth Steel Castings: the Sharon Steel Casting Company, Sharon, Pa.*

*Illustrated Catalogue of Improved Hydraulic Jacks: Watson & Stillman, New York.*

## BOOKS RECEIVED.

*On Steel Rails, Considered Chemically and Mechanically: by Christer P. Sandberg.* London, England; reprinted from the *Proceedings* of the Institution of Mechanical Engineers.

*Official Railroad Map of Nebraska: Compiled by the State Board of Transportation.* Lincoln, Neb.; published by the Board of Transportation.

*The Taylor Iron Works Diary for Railroad Men*, for 1891. High Bridge, N. J.; the Taylor Iron Works. This is the new number of the very neat and convenient pocket diary which this company has issued annually for a number of years past.

*Cornell University Register*, 1890–91. Ithaca, N. Y.; published by the University.

*Cornell University, College of Agriculture: Bulletin of the*

*Agricultural Experiment Station. XXIII, December*, 1890. Ithaca, N. Y.; published by the University.

*Institution of Mechanical Engineers: Proceedings, July*, 1890, *Sheffield Meeting*. London, England; published by the Institution.

*Information Required for the Designing of Structural Iron and Steel Work: by F. Stuart Williamson*. New York; published by the Author.

*Report of Committee on Coke Iron Manufactures for the City of Marquette*. Marquette, Mich.; the Citizens' Association.

*Reports of the Consuls of the United States to the State Department: No.* 121, *October*, 1890. Washington; Government Printing Office.

*Refrigerators and Food Preservation in Foreign Countries: Special Consular Reports to the Department of State*. Washington; Government Printing Office.

*Air-Brake Rigging; its Character, Maintenance and Operation: by R. A. Parke, M.E.* New York; published by the New York Railroad Club. This is a reprint of an excellent paper read by Mr. Parke at the December meeting of the New York Railroad Club.

*Irrigation in India: by Herbert M. Wilson, C.E.* New York; reprinted from the *Transactions* of the American Society of Civil Engineers.

## ABOUT BOOKS AND PERIODICALS.

THE articles on Southern California, by Mr. Charles Dudley Warner, are continued in HARPER'S MAGAZINE for January. The South American paper by Mr. Child in this number is on Peru, describing his general impressions of the country and its present material condition.

In the POPULAR SCIENCE MONTHLY for January Mr. Durfee's article on the history of Iron Manufacture in America is continued by a chapter on Iron Mills and Puddling Furnaces. Professor Samuel Sheldon has an interesting article on the storage of Electricity. Among the other articles given are a paper on the Decline of Rural New England, by Professor A. N. Currier, and M. Armand de Quatrefages' discourse on the Peopling of America.

In its issue for January 3 the ENGINEERING AND MINING JOURNAL gives statistics of the mining industries of the United States which make it a very valuable number for present reading and for reference.

The leading articles in the latest quarterly number of the PROCEEDINGS of the United States Naval Institute are on the Protection of the Hulls of Vessels by Lacquer, by Lieutenant J. B. Murdock; a Study of the Movements of the Atmosphere, by Lieutenant E. Fournier, of the French Navy; Assistant Secretary Soley's address at the unvailing of the Jeannette Monument; Lieutenant W. F. Fullam's paper on Naval Training and Discipline, and the discussion on that article.

In the January number of BELFORD'S MAGAZINE Henry George, Jr., has a somewhat intemperate article against the increase of the Navy. The other more serious papers are on Interest and Usury Laws, by Frederick T. Jones; on the Lake Region of Wisconsin, by B. P. Legare, and on the Fine Art of Walking. There is the usual variety of fiction and lighter articles, and some sharp and pointed editorial discussion of current affairs.

In SCRIBNER'S MAGAZINE for January there is given the second of Sir Edwin Arnold's papers on Japan. Another article on travel is Josiah Royce's Impressions of Australia—a country about which most of our people know very little. Modern Fire Apparatus, by John R. Spears, is a practical and interesting paper. Mr. William P. P. Longfellow discourses from the Architect's Point of View, giving his ideas in a striking and forcible way.

The difficulty of establishing a new magazine is well known, and makes more remarkable the success which the ARENA has attained in a little over a year. This is doubtless due to the fact that intelligent readers appreciate free and courageous discussion of live questions, for which the new magazine has given an opportunity never before so fully afforded.

The skater, the wheelman, the canoeist, and indeed almost every class of reader, will find something to interest him in OUTING for January. Not only out-door sports, but travel find room in its columns. The military papers, which have attracted much attention, are continued in this number by an interesting article on the Active Militia of Canada, which deserves a careful reading on this side of the line.

The Chattanooga TRADESMAN has made its issue of January 1 a "Census" number, in which is given a great variety of interesting matter concerning the growth of manufacturing enterprises in the South, and the resources of that section. Chattanooga itself is a center of industrial progress, and is well represented by our enterprising contemporary.

The leading article in the January number of the JOURNAL of the Military Service Institution is the prize essay of the Institution for the year; it is by Lieutenant George W. Read, Fifth Cavalry, and is on a Practical Scheme for Training the Regular Army in Field Duties for War. Other articles are on Artillery School Methods, by Lieutenant Hunter; the Marksman's Method of Defeating an Army, by Captain Chester; Strategy, Tactics and Policy, by Lieutenant Bush; the Gyroscope and Drift, by Lieutenant Richmond; Practical Education of the Soldier, by Lieutenant Parkhurst. The historical sketch for the month is of the Eighth Cavalry, by Lieutenant O'Connor.

The JOURNAL will hereafter be edited by Major William L. Haskin, First Artillery, Brevet Brigadier-General T. F. Rodenbough having retired from the position after a service of 12 years, on account of the pressure of other duties. It is largely due to General Rodenbough's experience and judgment that the JOURNAL has attained its present high standing as a service magazine.

## FORNEY'S SAFE DEPOSITORY FOR SLEEPING-CARS.

NEARLY every person who has had occasion to travel in sleeping-cars has experienced the nervousness and anxiety which attends the disposition and care of his pocket-book and other valuables during the night. The invention illustrated herewith is intended to afford a receptacle or depository in which small articles liable to be stolen can be locked up for safe keeping. Fig. 1 is a perspective view, showing a section of a sleeping-car provided with two safe depositories *A* and *B* below the windows. Fig. 2 is a transverse section on an enlarged scale through one of these, showing the window recesses below the two sashes, the outside of the car being on the left side of the engraving. The full lines *B C D* represent a half cylinder made of brass, in the position it occupies when the recess or depository is closed. The semi-cylinder has a head at each end. These heads are fastened by pivots *A* to the window-posts, so that the cylinder can be revolved about these pivots from the position shown by full lines *B C D* to that represented by the dotted lines *B C D*. When in the latter position the recess can be used as an arm-rest in daytime, or a receptacle for books and other small articles or packages. Nearly every one who has traveled in sleeping-cars has experienced the discomfort and inconvenience of the small arm-rests ordinarily used in that class of vehicles below the windows. The window recess furnishes a very comfortable arm-rest in the daytime when

Fig. 1.

FORNEY'S SAFE DEPOSITORY FOR SLEEPING CARS.

the half cylinder is turned back into it, as shown by the dotted lines in fig. 2, and as represented at *A* in the per-

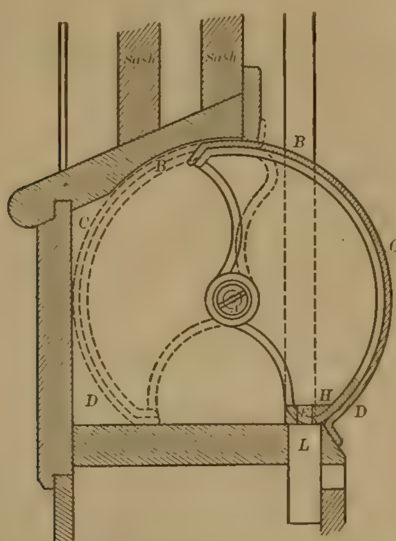



Fig. 2.

spective view. At *B* the safe depository is shown closed, or in the position it would occupy at night.

In fig. 2 *L* represents a lock which requires the use of two keys to open it. One of these keys is retained by the conductor of the car, and the other is delivered to the passenger. Neither of them can thus open the safe depository without the co-operation of the other, and in case the passenger's key was stolen it would do the thief little good; or if the conductor was disposed to do so he could not unlock the depository without the co-operation of the passenger or procuring his key. *E* is the bolt of the lock which engages with a hasp *H*.

It will be noticed from fig. 2 that the recess below the two sashes is nearly as wide as the whole thickness of the side of the car. Consequently the space *D H* gives an arm-rest over six inches wide. This is equivalent to widening the seat to nearly that extent, as the old arm-rests are not needed when the recess is used, and the passenger can then sit close up to the side of the car without the sensation of being disagreeably crowded, which he feels when there is no suitable rest for his arm.

The receptacle of each of the safe depositories is large enough to take a gentleman's vest or waistcoat, a light coat, or any small package. Locking up his valuables at night gives a pleasant sense of security to a traveler which is conducive to sound sleep and prevents loss by theft, of which most travelers, but especially ladies, are apprehensive when their money, their watches and jewelry are not locked up.

This device is the invention of Mr. M. N. Forney, whose address is at 145 Broadway, New York.

## THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.

By A. Zdziarski, Engineer.

(*Continued from page 27.*)

### III.—THE BAIKAL LOOP LINE.

While in the original design of the Great Siberian Railroad the Baikal Loop Railroad was not specified, the many disadvantages presented by the other means of communication between Irkoutsk, the terminus of the Central Siberian Railroad, and the eastern shore of Lake Baikal, or the town of Verkhne-Oudinsk, the proposed starting-point of the Trans-Baikal Line, induced the Government to order the exploration of a connecting line or loop. This was placed under charge of the Chief Engineer of the Trans-Baikal Survey. The disadvantages referred to are briefly stated below.

The period of open navigation from Irkoutsk to Verkhne-Oudinsk—which is on the Selenga River, a tributary of Lake Baikal—lasts only 4½ months, and a transfer of freight would be necessary at the mouth of the Selenga. Navigation from Irkoutsk to the eastern shore of Lake Baikal is open for six months, since the Selenga usually freezes over nearly two months earlier than the lake. In winter there is a good sledge road from Irkoutsk to the eastern shore of the lake for 3½ months, but the sledge road to Verkhne-Oudinsk lasts only one month, on account of the very light snowfall in the Trans-Baikal.

These circumstances made it very desirable that the loop line should be built, and that, at least, the Trans-Baikal Railroad should start from some point on the eastern shore of the lake.

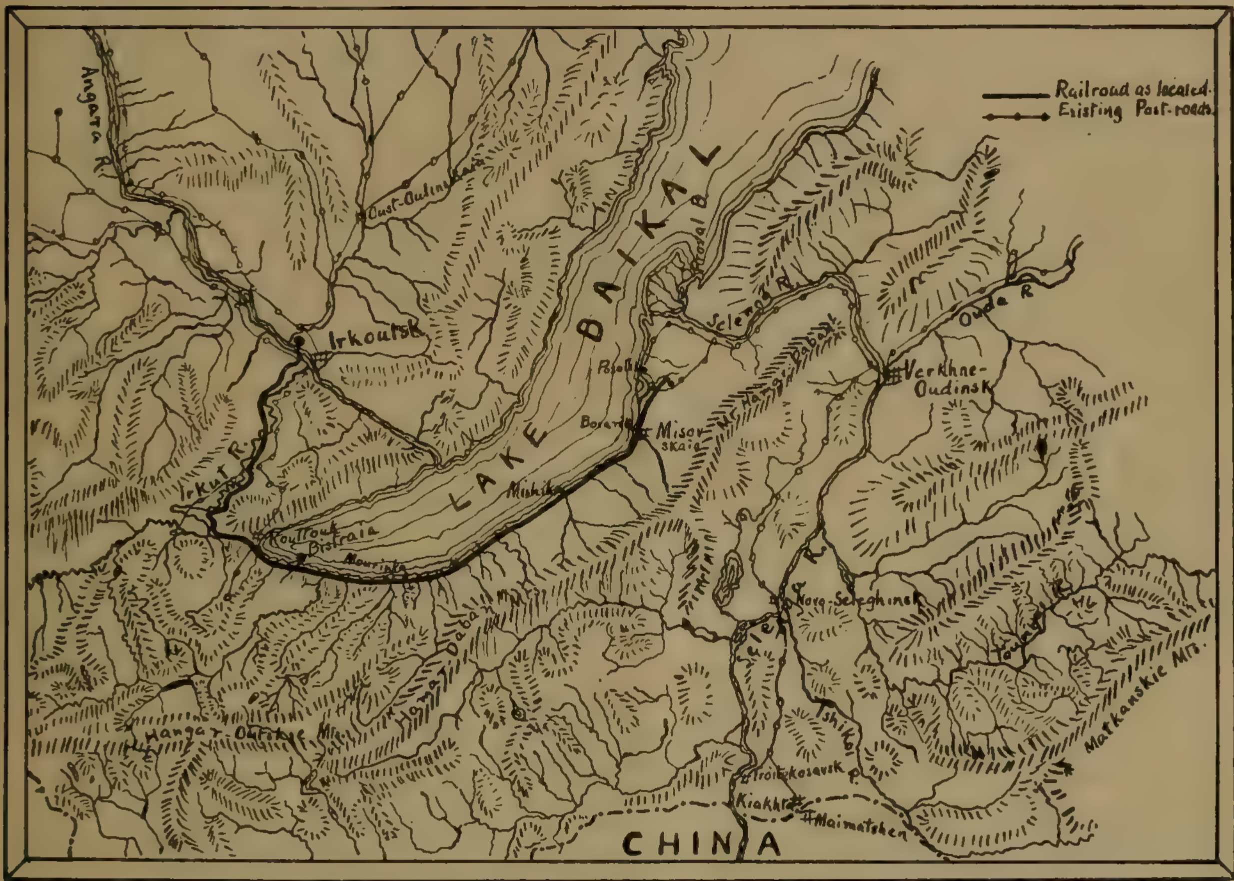
The exploration of the Baikal Loop Line, although called only a reconnoissance, was made with the same accuracy as an ordinary survey, instrumental longitudinal and cross leveling being applied to the main line, barometer leveling being used only in the preliminary work.

The general location was governed from the north by Lake Baikal. The shortest line must pass through Koultouk, and go eastward, following the south shore of the lake.

Three different lines were barometrically explored from Irkoutsk to Koultouk, the first following the Irkout River, crossing the Zirkizoun Range through a pass 770 ft. above the lake level and descending the Valley of the Koultoushka River. The other two lines were abandoned, the first, which followed the post road, having, within 6 miles from Koultouk, to cross the sources of the Great Zazara, a tributary of the Irkout, at a height of 1,330 ft., requiring a long tunnel; while the other was impracticable for the reason that the western shore of Lake Baikal is very tortuous and presents bluffs 1,200 to 1,400 ft. high, so that even with a radius of curvature of 840 ft., numerous tunnels would be required; moreover, the banks of the Angara are nearly 200 ft. in height and the line would be some 17 miles longer than the first.

The selected line is 83½ miles long from Irkoutsk to Koultouk, and can be built with grades of 1.2 per cent. A tunnel about 2½ miles long, through the neck of a loop or bend in the Irkout River, would shorten the line about 20 miles.

The second part of the line, from Koultouk to the harbor of Misovskaia on the eastern shore of Lake Baikal, which was selected for the starting-point of the Trans-Baikal Line, follows closely the shore of the lake. All the trials to find a suitable pass through the Hamar-Daban Range were unsuccessful. The first route surveyed, starting from the Mourinska River, crossed two divides, the first 4,252 ft. high and requiring grades of 3 per cent., the second divide presenting grades of 5 per cent. Another




BAIKAL LOOP LINE, GREAT SIBERIAN RAILROAD.

route, starting from the Mishika River, traversed the range at a height of 3,354 ft., with grades of 2.5 per cent. Others gave no better result, and none of the passes of the Hamar-Daban were found suitable for a railroad line, so that the lake-shore route was adopted.

The whole length of the located line from Irkoutsk to Misovskaia is 194 miles, and it can be divided into three sections, as below.

1. From Irkoutsk to Moïgot, 62 miles. This is a light mountain section, and the location was made accordingly, assuming the additional train-resistance due to curvature and gradients at 10.50 kilogrammes per ton; which corresponds to a radius of curvature of 1,050 ft. and a grade of 0.8 per cent., or to a radius of 840 ft. and a grade of 0.7 per cent.*

2. From Moïgot to Bistraia, 36 miles. This is a mountain section, conformed to a train-resistance of 13.77 kg. per ton; which corresponds to a radius of curvature of 1,400 ft. and a grade of 1.2 per cent., a radius of 1,050 ft. and a grade of 1.1 per cent., or a radius of 840 ft. and a grade of 1.05 per cent.

3. From Bistraia to Misovskaia, 96 miles. This was located under the conditions of a level section, but with the allowance of minimum radius of curvature of 1,400 ft. The train-resistance was limited to 9.11 kg. per ton; which corresponds to a radius of curvature of 2,100 ft. and a grade of 0.8 per cent., a radius of 1,750 ft. and a grade of 0.75 per cent., or a radius of 1,400 ft. and a grade of 0.7 per cent.

It was assumed that the trains would be the same as on the Trans-Baikal Railroad, and all the conditions adopted are for three daily trains each way, with a possible increase to seven trains.

The grade is designed for single track, of 5 ft. gauge; the width of grade is assumed at 16.8 ft. The greater part of the excavation is in rock, where the slopes will be 1 : 2. The same slope is designed for retaining walls. The average quantity of earthwork is computed at 70,000 cub. yds. per mile.

The soil found on the first 10 miles is sand; then for 8 miles loose rock—red sandstone; on the 30th mile solid rock—granite and gneiss; the same rock is found in the pass through the divide between the Irkout River and Lake Baikal. On the southern shore of the lake, from the 89th to the 119th mile from Irkoutsk, we meet many rocky bluffs, containing lapis lazuli, marble, gneiss and granite. From the 119th mile, the Mourina River, there is no more rock.

The heaviest cuttings, reaching 84 ft. and 105 ft. in depth, will be in the bluffs on the Irkout River and at the entrance to the tunnel; on the 59th mile there are cuts of 70 to 105 ft. in depth and a length of 1,050 ft. The average depth of the other cuts is from 20 to 30 ft.

The embankments are not high, with the exception of the grade on the approach to the tunnel, where one 70 ft. high will be required. The larger embankments will be made with retaining walls of dry masonry, or will be protected by rip-rap.

On the second section, on the descent to Baikal, there are cuttings of 55 ft. in depth, and embankments of stone, 118 ft. high; trestle-work is not considered suitable here, in view of the small radius of curvature, 840 ft.

Some heavy work will also be required in crossing the Kirkidaï Gap, on the 81st mile, where there is one cutting 98 ft. deep, two 38 ft. deep and embankments 42 ft. and 49 ft. high, the former with retaining walls. Some retaining walls will be required on the 96th and 98th miles, on the lake shore, to protect the grade from high waves and from ice.

The Baikal Loop Line, especially in the valley of the Irkout and on the southern shore of Lake Baikal, will require numerous bridges. In all 331 bridges are designed with a total length of 10,234 ft. As a rule these bridges will be of wood, bridges with masonry abutments and wooden or iron superstructure being designed only as exceptions, at points where there is danger from ice.

The greatest bridge will be over the Irkout River, with a clear span of 560 ft. It will have stone abutments with ice-breakers and iron superstructure. Another iron bridge of 140 ft. span will be used over the Pereemna River, on account of the great wave or tidal motion. These two bridges will require 870 tons of iron.

There will be 69 small bridges of 7 ft. span and 9 of 14 ft. span, all of wood on stone abutments. Masonry culverts will be used only in the approach to the tunnel, in descending the eastern slope of the Zirkizoun Range, and in traversing the Kirkidaï Gap. There will be 12 of 7 ft. span and 2 of 14 ft. span.

The other bridges will all be of wood and will be of the following lengths: 135 of 14 ft.; 22 of 21 ft.; 54 from 28 to 70 ft.; 9 from 70 to 140 ft.; 1 of 210 ft., over the Outoulouk River; 1 of 245 ft., over the Mourin River; 1 of 280 ft., over the Baratouï River; 1 of 315 ft. over the Snejnaia (Snow) River. This is a total of 224 bridges. There will be viaducts from 63 ft. to 112 ft. high, on the 75th, 77th and 79th miles.

One great tunnel is designed, through the Zirkizoun Range; its length will be 12,523 ft., and it will pass through granite and gneiss and will require no arching or lining. This tunnel will have a single grade and no curves. A small tunnel, 224 ft. long, will be required on the bank of the Irkout.

The distance arranged between stations is 33 miles; between water tanks, 19 miles, and between sidings, 10 miles. For operating purposes the road will be divided into two nearly equal sections, No. 1, from Irkoutsk to Bistraia, 97.5 miles, being a mountain or heavy-grade section; No. 2, from Bistraia to Misovskaia, 96 miles, being a level section.

The first section will have three fourth-class stations, three water stations and six places for future sidings. The second section will have two fourth-class stations, three water stations and six places for future sidings. Bistraia will be a divisional point, and will have a third-class station and an engine-house.

The engine-houses will have 31 stalls in all. Minor buildings include 48 section-houses and 59 watchmen's houses. All the buildings will be of wood and of the same general character as those on the Trans-Baikal Line.

The water supply presents no difficulties, rivers being plenty, and on a great part of the line Lake Baikal being close by.

The supply of rolling stock, calculated for running three trains daily each way, and on the supposition that this loop and the Trans-Baikal Railroad will be worked as a continuous line from Irkoutsk to Sretensk, will be 46 locomotives, 8 passenger cars and 220 freight cars.

Materials for building the road are found under satisfactory conditions. Sand and gravel for ballast can be obtained from the banks on the southern shore of Lake Baikal, and the bluffs in the valley of the Irkout. Stone—chiefly granite—is found on the line from the 98th to the 119th mile, and is nowhere far from it. Timber—cedar, pine, hemlock and larch—is abundant everywhere on the shores of Lake Baikal and in the valley of the Irkout. Clay is found only at a few points; limestone is found also at a few points, and is probably not scarce.

The cost of this line, 194 miles long, is approximately estimated at 24,000,000 roubles, or 123,711 roubles per mile. This cost—about $65,000 per mile—will make it the most expensive section of the Siberian road.

### IV.—THE CENTRAL SECTION.

The Central Siberian Railroad, the Baikal Loop Line and the Trans-Baikal Railroad together form a continuous line, connecting the watershed of the Obi with that of the Amour. The total length of this line and its estimated cost is given in the accompanying table.

This line will start from Tomsk on the Tom, a tributary of the Obi, and end at Matakan (Sretensk), on the Shilka, a tributary of the Amour, and will be the heart or core of the Great Siberian Railroad.

The continuation of this railroad will be by the steamboat line, which, starting from Sretensk, follows that river to

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* The formula used for calculating train resistance in kilogrammes per ton is:

$$\text{Resistance} = \left(\text{Gradient} + \frac{0.65}{\text{Radius} - 55 \text{ meters}}\right) 1000.$$

The radius is to be given in meters.

| Section. | Length in Miles. | Cost in Roubles. | |
|---|---|---|---|
| | | Total. | Per Mile. |
| Central Siberian Railroad ....... .... | 1,038 | 69,000,000 | 66,300 |
| Baikal Loop Line ........... ....... | 194 | 24,000,000 | 123,700 |
| Trans-Baikal Railroad............... | 663 | 55,000,000 | 82,200 |
| Total ........................... | 1,895 | 148 000,000 | 78,100 |

the Amour, then the Amour to the point where it bends northward, and thence follows up the Oussouri to Grafskaia, which will be the starting-point of the Oussouri Railroad, the last section of the line.

The distance by river from Sretensk or Matakan to Grafskaia is about 1,590 miles; at present the journey requires about 10 days, but this can be shortened if necessary.

(TO BE CONTINUED.)

## NATIONAL CONVENTION OF RAILROAD COMMISSIONERS.

THE following circular has been issued by the Committee appointed last year, which consists of Judge Thomas M. Cooley, Chairman; E. W. Kinsley, of Massachusetts; I. A. Spalding, of Kentucky; D. P. Duncan, of South Carolina; and J. P. Williams, of Minnesota. The circular fully explains itself.

At a Convention of Railroad Commissioners held at the City of Washington on the 6th day of March, 1889, the following resolution was adopted:

"*Resolved*, That it is the opinion of the members of this Convention that provision should be made for annual conventions of the Railroad Commissioners of the several States and the members of the Interstate Commerce Commission, to be held at such place as may be agreed upon, with a view of perfecting uniform legislation and regulation concerning the supervision of railroads."

In pursuance of this resolution a Convention was held at the City of Washington, beginning on the 28th day of May, 1890, at which the undersigned were appointed a Committee to call the next Convention.

Under the authority conferred upon them the undersigned designate the 3d day of March, 1891, at 11 o'clock in the forenoon, as the time, and the office of the Interstate Commerce Commission, No. 1317 F Street, Sun Building, in the City of Washington, D. C., as the place for the holding of said Convention.

The Railroad Commissioners of all the States, and any State officers charged with any duty in the supervision of railroads or railroad interests, are respectfully requested to attend. The American Association of Railway Accounting Officers is also invited to meet with the Commissioners, or to send delegates to the Convention, for the discussion of such questions of special interest to their Association as may arise at the meeting.

The undersigned respectfully suggest the following as subjects which may usefully be considered by the Convention:

1. *Railway Legislation:* How harmony therein may be attained.

2. *Uniformity in Railway Accounting:* What further is important to that end.

3. *Territorial Assignment of Statistics of Operation:* Whether this is not practicable, and what principles should control in grouping railway statistics.

4. *Apportionment of Expenses to Freight and Passenger Traffic:* What reasons there are for making such an apportionment, and what rules should be adopted.

5. *Safety Appliances for Railroad Cars:* What legislation, if any, should be had by Congress.

6. *Reasonable Rates:* What are, and the elements to be considered in the determination thereof.

In offering these suggestions it is not intended that they shall be understood as excluding any other topics affecting State and Interstate Commerce which could properly come before and be entertained by such a Convention.

## THE PANAMA CANAL.

(From the New York *Times.*)

THE new concession for a canal across the Panama Isthmus, or the extension of the old one under new conditions, was approved by the Colombian Government on December 20. A dispatch from Paris said that it had been accepted and signed by the Liquidator of the bankrupt canal company, but in a later dispatch from the same city, it was stated that the new contract was still awaiting "the ratification of the Liquidator, whose opinion is not hopeful as to the resurrection of the concern." The exact terms of the new concession have not been announced in this country, although Lieutenant Wyse's original proposition and the modifications suggested by the Colombian Government while the negotiations were in progress, together with a very short telegram as to the prominent features of the final agreement, indicate pretty clearly what they are. Lieutenant Wyse's offer was that a new company or the old one reorganized should pay $2,400,000 in eight annual instalments for the land to be used, with $1,000 000 in paid-up shares and $72,000 per annum for the support of a military force. The committee of the Colombian Senate recommended that $6,000,000 should be paid in cash, with $2,000,000 in paid-up shares. The provisions of the bill, as they stood in October, were that the new company should pay $4,000,000, with shares and privileges to the value of $4,000,000, the money to be delivered in five yearly instalments. A telegram from Panama on December 22 reported that under the approved agreement the new company was to pay $2,000,000 in five yearly instalments, $1,000,000 in privileged shares, and the garrison expenses, and was also to pay for the land to be used. Twenty-six months are allowed for the formation of the new company and a resumption of the work.

The available cash assets of the old company in March last were $3,200,000. There were also the company's interest in the railroad, its buildings and machinery on the isthmus, and its unissued lottery bonds, which then had a market value of about $13,000,000, owing to the fact that they had been secured by a deposit with the Crédit Foncier. It seems probable that there could be obtained out of the wreck enough money to meet the conditions of the new concession, but it is necessary also to supply a new company with resources large enough to carry on the work. The old company, by incurring obligations exceeding $400 000,000, obtained $265,938,000. It expended only $156,600,000 of this on the Isthmus. The Commission of engineers sent to the Isthmus by the Liquidator reported that the cost of completing the work with locks would be $180,000 000. Even if a new company could raise the money in any way, it would be necessary to incur obligations amounting to not less than $250,000,000. Thus far there is not the slightest indication that any group of capitalists can be induced to take up the work, nor is there any probability that the money can be procured by popular subscription in France.

The same Commission, assuming that a canal with locks could be made in eight or ten years, estimated that not until four years after the completion of it would the annual tonnage amount to 4,100,000. With traffic charges greater by 25 per cent. than those of the Suez Canal, the income would then permit the payment of only 4 per cent. on the new company's investment, and the interest would not exceed 6 per cent. eight years later. But it does not appear that the proposed canal with locks would permit the passage in a year of more than two-thirds of the quantity of tonnage which goes through the Suez Canal (which was 6,783,000 in 1889), and the Commission reported that the company could not rely upon more than 320 working days in a year, owing to the climate and other conditions. A careful study of the facts and estimates submitted by the Commission does not disclose anything to encourage a syndicate or a new company to take hold of the work. The sum to be invested is too large, the natural obstacles are too formidable, and the possible income would be too

small. Moreover, a competent and trustworthy organization is making another canal in Nicaragua. But Lieutenant Wyse has not procured this extension of the old concession without having in mind some project for utilizing it, and the world will await with some curiosity the development of his plans.

## THE USE OF WOOD IN RAILROAD STRUCTURES.

BY CHARLES DAVIS JAMESON, C.E.



(*Concluded from page* 14.)

### CHAPTER XXXI.

#### HOWE TRUSS BRIDGES.

THE plans for Howe truss bridges were to be completed in the January number of the JOURNAL; but it has been considered best by the Author to supplement, or rather to complete, them by a design for a long span bridge. This design, which is for a through span of 132 ft., is given in the present number. The plans contained in Plates 129, 130 and 131, with the accompanying bill of material, give all the information required for the engineer. It has not been thought necessary, however, to repeat all the drawings for the smaller castings, and accordingly some references will be found in the list of iron-work, to plates published in previous numbers of the series.

It may be well to repeat here the remark made in some previous chapters, that the kind of wood specified in the bill of material is that which has been most approved by experience for the purpose. It may sometimes be necessary, owing to local circumstances, to substitute some other kind of timber; but in such cases the judgment of the engineer must be exercised in choosing the best timber attainable for his purpose.

No. 53. BILL OF MATERIAL FOR HOWE TRUSS BRIDGE. THROUGH SPAN, 132 FT. PLATES 129, 130 AND 131.

*Timber.*

| No. of Pieces. | Description. | Size. | Length. | Feet B. M. | Kind of Wood. |
|---|---|---|---|---|---|
| 32 | Top Chord...... | 7 in. × 12 in. | 22ft. 0½in. | 4,928 | Yellow Pine. |
| 8 | " " ...... | 7 in. × 12 in. | 18ft. 6⅜in. | 1,040 | " " |
| 8 | " " ...... | 7 in. × 12 in. | 7ft. 6⅛in. | 424 | " " |
| 16 | Bottom Chord.. | 7 in. × 14 in. | 44ft. 0 in. | 5,760 | " " |
| 4 | " " ...... | 7 in. × 14 in. | 41ft. 6 in. | 1,358 | " " |
| 4 | " " ..... | 7 in. × 14 in | 30ft. 6 in. | 1,000 | " " |
| 4 | " " ..... | 7 in. × 14 in. | 19ft. 6 in. | 640 | " " |
| 4 | " " ..... | 7 in. × 14 in. | 8ft. 6 in. | 276 | " " |
| 8 | Braces......... | 12 in. × 18 in. | 27ft. 5⅛in. | 3,960 | " " |
| 8 | " ......... | 12 in. × 16 in. | 27ft. 5⅛in. | 3,520 | " " |
| 8 | " ...... ... | 12 in. × 14 in. | 27ft. 5⅛in. | 3,c80 | " " |
| [illegible] | " ......... | 10 in. × 12 in. | 27ft. 5⅛in. | 2,200 | " " |
| 8 | " . . ..... | 11 in. × 12 in. | 27ft. 5⅛in. | 2,920 | " " |
| 8 | " . ........ | 8 in. × 12 in. | 27ft. 5⅛in. | 1,760 | " " |
| 20 | Counters.... ... | 8 in. × 10 in. | 27ft. 5⅛in. | 3,(64 | " " |
| 4 | " ....... | 8 in. × 10 in | 15ft. 0 in. | 400 | " " |
| 2 | Laterals........ | 6 in. × 8 in. | 21ft. 6¼in. | 172 | " " |
| 4 | " .... ... | 6 in. × 8 in. | 19ft. 8 in. | 315 | " " |
| [illegible] | " .. ..... | 6 in. × 8 in. | 17ft 3⅞in. | 832 | " " |
| [illegible] | " ........ | 8 in. × 8 in. | 21ft. 6¼in. | 231 | " " |
| 16 | " ........ | 8 in. × 8 in. | 17ft. 3⅞in. | 1,488 | " " |
| [illegible] | " ........ | 8 in. × 8 in. | 20ft. 4¾in. | 436 | " " |
| [illegible] | " ........ | 6 in. × 8 in. | 13ft. 11¼in. | 112 | " " |
| 2 | " ....... | 8 in. × 8 in. | 13ft. 11¼in. | 150 | " " |
| 38 | Floor-beams.... | 9 in. × 16 in. | 19ft. 4 in. | 8,816 | " " |
| 6 | Stringers....... | 6 in. × 12 in. | 138ft. 0 in. | 4,968 | " " |
| 118 | Ties............ | 8 in. × 8 in. | 12ft. 0 in. | .... | Oak. |
| [illegible] | Guard-rails..... | 6 in. × 6 in. | 138ft. 0 in. | 828 | Spruce or Pine |
| 16 | Bolsters..... .. | 7 in. × 12 in. | 9ft. 0 in. | 1,008 | Yellow Pine. |
| 16 | Bridge-seats.... | 7 in. × 12 in. | 6ft. 0 in. | 672 | " " |
| 4 | Sills............ | 12 in. × 12 in. | 19ft. 4 in. | 928 | Spruce or Pine. |
| 4 | Planks.......... | 2 in. × 8 in. | 138ft. 0 in. | 736 | " " " |
| 8 | Blocks.......... | 2 in. × 8 in. | 2ft. 8 in | 28 | Oak. |

*Wrought-Iron—Rods and Bolts.*

| No. | Description. | Diameter. | Length. | No. | Description. | Diameter. | Length. |
|---|---|---|---|---|---|---|---|
| 12 | Rods....... | 3 in. | 28 ft. 10 in. | 16 | Bolster b'lts | 1¼ in. | 3 ft. 4 in. |
| 12 | " ...... | 2¾ in. | 28 ft. 10 in. | 268 | Chord bolts. | ¾ in. | 2ft 9½in. |
| 32 | " ...... | 2½ in. | 28 ft. 10 in. | 56 | String'rb'lts | ⅝ in. | 2 ft. 6 in. |
| 12 | " ...... | 2 in. | 28 ft. 10 in. | 52 | T'k strg'b'ts | ¾ in. | 2 ft. 10 in. |
| 8 | " ... .. | 1¾ in. | 28 ft. 10 in. | 76 | Fl.beam b'ts | 1¼ in. | 3 ft. 0 in. |
| 6 | Laterals.... | 1¾ in. | 20 ft. 0 in. | 80 | Tie-bolts... | ⅝ in. | 2 ft. 6 in. |
| 16 | " ... | 1½ in. | 20 ft. 0 in. | 42 | G'rd-r'l-b'ls | ¾ in. | 1 ft. 4 in. |
| 8 | Counters.... | 1 in. | 15 ft. 6 in. | 24 | Brace-bolts. | ¾ in. | 2ft. 9½in. |
| 16 | Bolster b'lts | 1¼ in. | 2 ft. 4 in. | 104 | Spikes..... | ½ in. | 9 in. |

*Other Iron Work.*

*Washers* (see Plate 120): 44 of pattern *H*; 216 of *G*; 1,100 of *F*.
*Castings* (see Plate 130): 36 of pattern *A*; 36 of *B*; 8 of *C*.
*Castings* (see Plate 131): 8 of pattern *A*; 36 of *B*; 8 of *C*.
*Castings* (see Plate 133): 8 of pattern *B*.
*Castings* (see Plate 134): 4 of *B*—end brace-block.
*Castings* (see Plate 117): 8 of pattern *F*; 112 of *I*.
*Castings* (see Plate 121): 192 of pattern *L*; 196 of *M*, 80 of *O*; 40 of *P*; 80 of *Q*.

## RAILROAD ACCIDENTS IN GREAT BRITAIN.

THE returns of accidents and casualties, as reported to the Board of Trade by the several railway companies in the United Kingdom, during the six months ending June 30, 1890, which has at length been published, exhibits a considerable decrease in the number of passengers killed and injured as compared with the corresponding period of last year, which is mainly due to the fact of the Armagh disaster having occurred in the first half of the year 1889.

The total number of personal accidents reported during the six months amounts to 499 persons killed and 5,108 injured. Of these, 51 passengers were killed and 673 injured; railway servants killed, 231; injured, 4,232; other persons (trespassers, suicides, etc.), 217 killed and 203 injured.

During the half-year 55 collisions between trains took place in which persons were either killed or injured. These are distinguished as to their nature and results in the following manner.

Eleven collisions between passenger trains, or parts of passenger trains, by which 22 passengers and one servant were injured; 32 collisions between passenger trains and goods or mineral trains, etc., by which five passengers and two servants were killed, and 80 passengers and 26 servants injured; 12 collisions between goods trains or parts of goods trains, by which one passenger and one servant were killed and two passengers and 14 servants were injured.

There were reported 363 failures of tires, of which 9 were on engines, 4 each on tenders and carriages, 10 on break vans, and 336 on wagons, 259 of which belonged to private owners. Of these tires 302 were of iron and 61 of steel; 17 of them broke at rivet holes, 1 at the weld, 70 in the solid, 272 split longitudinally or bulged, while 3 that failed did not break.

The failures of axles numbered 132, of which 75 were on engines (67 being driving and 8 leading or trailing axles), 5 were tender axles, 4 carriage axles, and 48 wagon axles (3 being on salt wagons, and 16 of the wagons belonging to private owners). Of the 67 driving axles, 28 were made of iron and 39 of steel; the average mileage of 25 of the iron axles was 184,915 miles, and of 36 of the steel axles 209 941 miles.

The breakage of 115 rails is reported, of which 44 were double-headed, 60 single-headed, 1 bridge pattern, and 4 Vignoles' pattern. Twenty-five of the double-headed rails have been turned. Of the total number of rails that broke, 108 were of steel and 7 of iron.

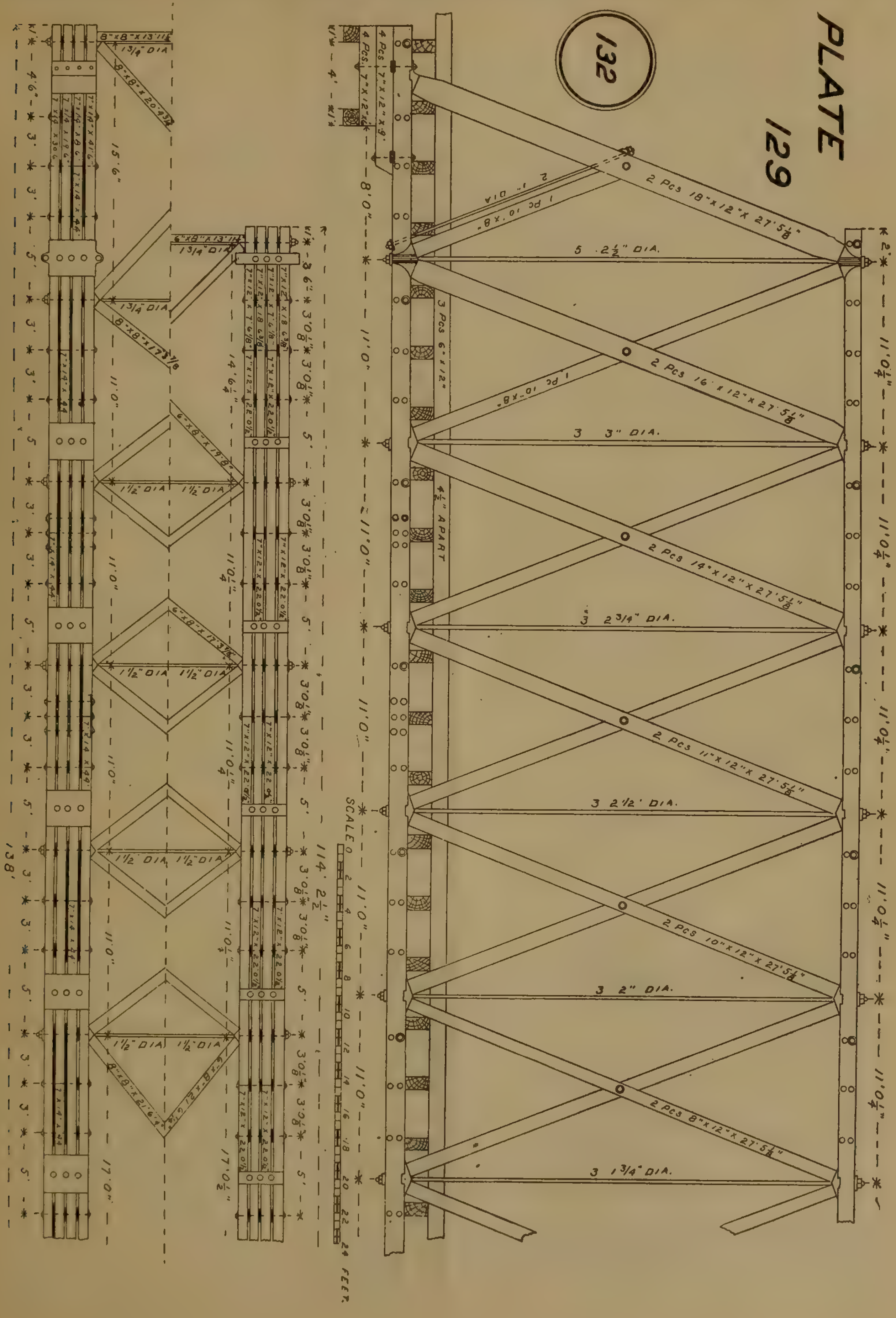
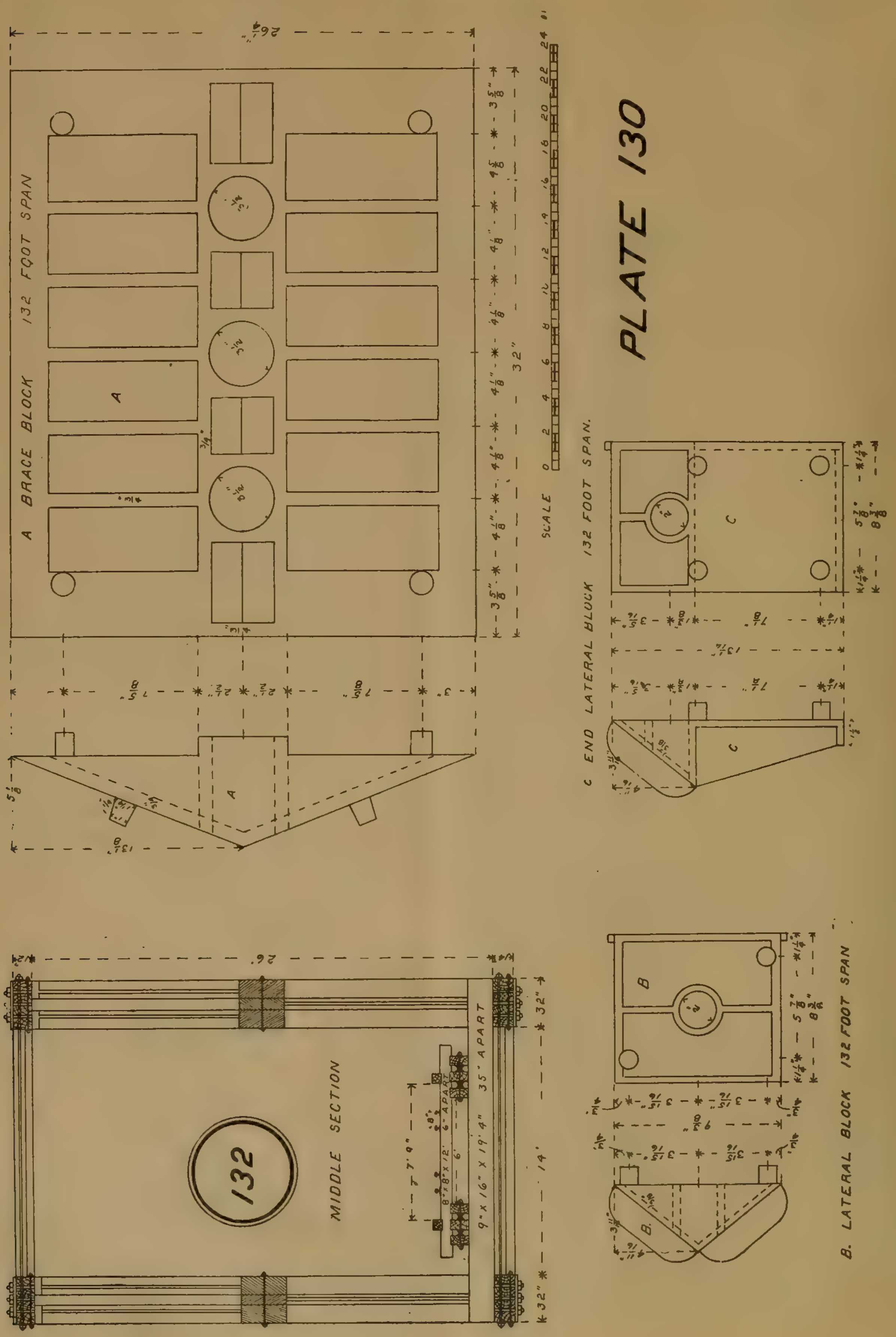


PLATE 129
132
2 Pcs 18"x12"x 27'5 1/8"
2 Pcs 16"x12"x 27'5 1/8"
2 Pcs 14"x12"x 27'5 1/8"
2 Pcs 11"x12"x 27'5 1/8"
2 Pcs 10"x12"x 27'5 1/8"
2 Pcs 8"x12"x 27'5 1/8"
5 2 1/2" DIA.
3 3" DIA.
3 2 3/4" DIA.
3 2 1/2" DIA.
3 2" DIA.
3 1 3/4" DIA.
1 Pc 10"x8"
3 Pcs 6"x12"
4 1/2" APART
4 Pcs 7"x12"x9'
SCALE 0 2 4 6 8 10 12 14 16 18 20 22 24 FEET
114' 2 1/2"
138'
8'0"
11'0"
17'0"
15'6"
14'6 1/2"
17'0 1/2"
11'0 1/4"
1 1/2" DIA
1 3/4" DIA
8"x8"x13'11"
6"x8"x13'11"


A BRACE BLOCK 132 FOOT SPAN
PLATE 130
SCALE
C END LATERAL BLOCK 132 FOOT SPAN.
132
MIDDLE SECTION
9" x 16" x 19' 4" 35' APART
B. LATERAL BLOCK 132 FOOT SPAN

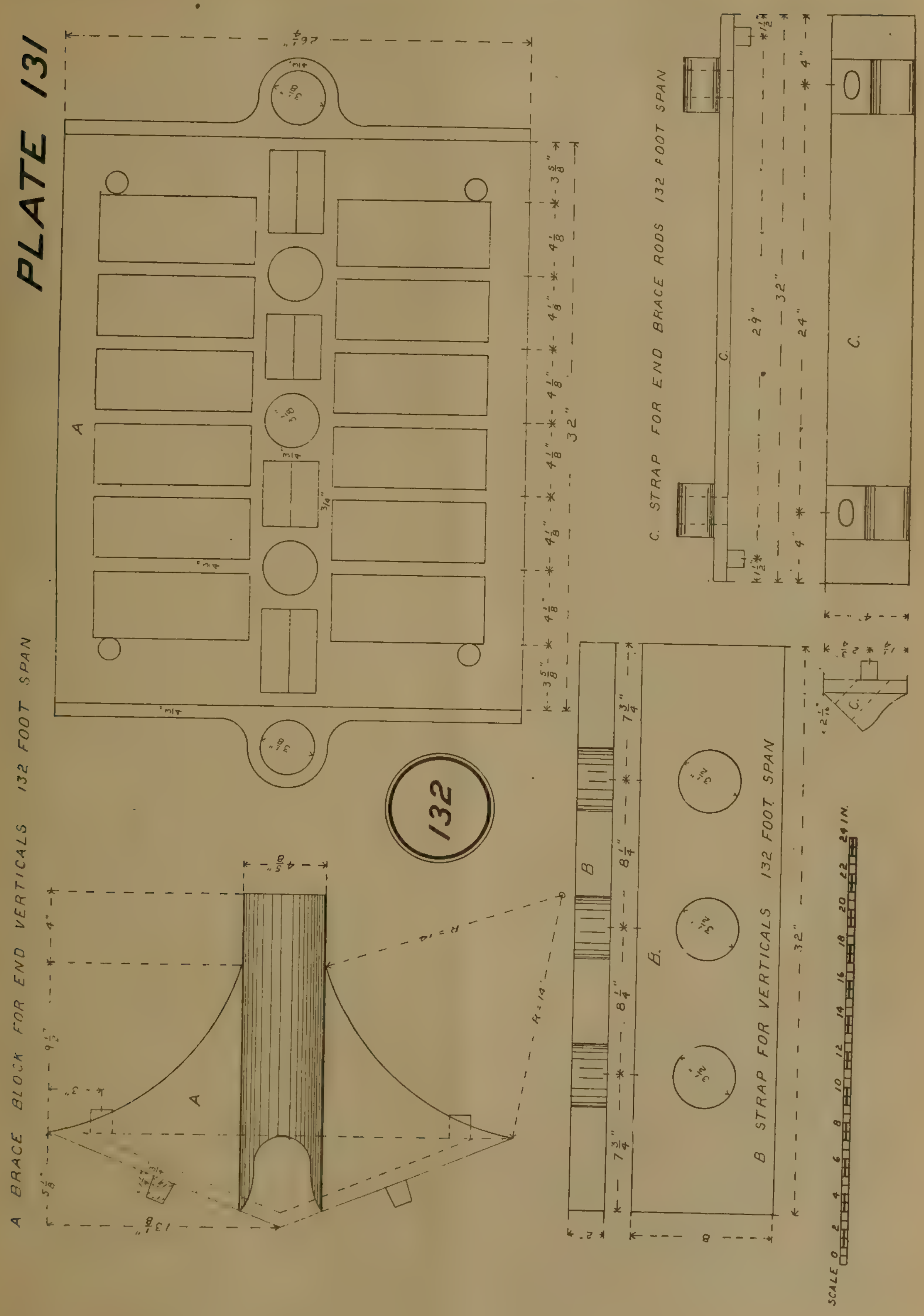



PLATE 131

A BRACE BLOCK FOR END VERTICALS 132 FOOT SPAN

B STRAP FOR VERTICALS 132 FOOT SPAN

C. STRAP FOR END BRACE RODS 132 FOOT SPAN

Of the 254 persons killed and 490 injured from causes other than accidents to trains, rolling stock, permanent way, etc., including accidents at level crossings and from want of caution or misconduct, 44 of the killed and 378 of the injured were passengers, and mostly met with their injuries in entering, leaving the carriages, or falling between trains and platforms.

Seventy-four persons met their deaths at crossings, level or otherwise, while 33 others were injured at those dangerous places; 117 trespassers were killed, and 33 others committed suicide on the lines during the six months.

Taking the return as a whole, it is not one that redounds to the credit of the railway companies, as it exhibits so many instances of their neglect to provide sound and proper materials and appliances, or to adopt the fullest possible precautions to ensure immunity from accident to the public and their servants.—*Railway Herald, London.*

## OUR NAVY IN TIME OF PEACE.

BY LIEUTENANT HENRY H. BARROLL, U. S. N.

(*Continued from page 22.*)

THERE are two main institutions for the professional training of the *personnel* of the United States Navy—the Naval Academy and the Training School; the former for the education of commissioned officers and the latter for naval apprentices, who afterward become warrant officers, petty officers, and seamen.

### THE NAVAL ACADEMY.

The United States Naval Academy is situated at Annapolis, Md. The site is a healthful one, the surrounding country being slightly rolling, while the Severn River, near its entrance into Chesapeake Bay, furnishes a fine stretch of water, suitable for boat-sailing, etc., and affords to the practice vessels a safe and convenient harbor. These vessels lie either alongside or near the wharves, thus allowing opportunity for sail and spar drill at all seasons of the year.

Here, since 1845, have been educated all Line Officers of the Navy; and in conformity with a law recently passed by Congress, vacancies in the Engineer, Construction and Marine Corps are now also filled by graduates from this institution. Surgeons, paymasters and chaplains are now the only commissioned officers who are appointed directly from civil life.

There are two ways in which admission to the Naval Academy may be obtained—appointment either by a member of Congress or by the President of the United States.

Each member of Congress or territorial delegate is entitled to have continuously at the Naval Academy a cadet representing that district or territory. There are allowed, also, to be continuously represented upon the academic rolls, ten cadetships "at large," and all appointments to fill vacancies which may occur among these are made by the President of the United States, who also has the appointing of the cadet representing the District of Columbia.

The academic course extending over six years, it will thus be seen that except for failure on the part of the candidate to pass the successive examinations, both Congressional and Presidential appointments would only ensue every sixth year; but there are vacancies occurring in these cadetships all along the line of the academic course, owing to resignations, dismissals, or failures to pass the regular examinations.

Whenever, through any cause, a vacancy occurs in the representation of a Congressional district or Presidential appointment, the member of Congress, delegate, or the President is notified of the fact by the Secretary of the Navy, and is requested to designate the person whom he may desire to have appointed on probation.

Of late it has become a custom for members of Congress to issue a call for a competitive examination among the students of the public schools of that district to which the vacancy belongs, and to award the appointment to the successful competitor; but this is by no means obligatory, and the law allows him to appoint any particular person he may choose to designate, without holding such competitive examination. The candidate nominated, however, must be over 15 and under 20 years of age, of good physique, fairly sized according to his age, and not afflicted with any bodily infirmity.

In case that by July these appointments have not been made by those persons who are authorized to designate the candidates, the law allows the Secretary of the Navy to fill them when application for them is made by any one who can in all respects satisfy the requirements for admission; the appointments, however, are much sought after, and therefore such a circumstance would be of rare occurrence.

The Secretary of the Navy, being in receipt of the name and address of the person designated as a candidate for admission, notifies him when and where to present himself for the examination which is necessary preliminary to his acceptance; for, notwithstanding that the cadet may have passed a most successful examination in competition for the appointment, he is yet required to show before the Academic Board of Examiners that he possesses a fair knowledge of the rudimentary branches—reading, writing, arithmetic, grammar, history, and geography. He must also be here physically examined, to prove that he is of sound health and robust constitution, before being admitted to the Academy as a student.

This entering examination, which takes place at the Naval Academy, is not a severe one to any youth of 15 years of age who has progressed even moderately well in his studies.

Having succeeded in passing the entering examination, the candidate is given a warrant, signed by the Secretary of the Navy, appointing him a Naval Cadet on probation. He is now allowed a salary of $500 a year and one ration, the latter being commuted at the rate of 30 cents per day, thus making a total of $609.50 annually. From this sum he is required to provide himself with board, clothing, books, washing, and all other necessary expenses. His accounts are retained in the hands of the Paymaster of the Naval Academy, and all articles purchased must be subjected to the approval of the Commandant of Cadets, and drawn on requisition, from the Government store. He is allowed to draw from his accounts, monthly, the sum of one dollar as spending money, and parents and guardians are requested not to furnish the cadets with additional funds. The object of this is to place all of the cadets on the same financial basis, and the effect of it is to avoid that reckless extravagance which is so often characteristic in college students.

From his yearly allowance there is retained, at the rate of $5 monthly, the sum of $60, which is termed "Reserved Pay," and which is paid over to the cadet, at the time of his leaving the Academy, that he may thus be sure of having the necessary means for providing himself with a sea-outfit when starting on service afloat.

The system of education as here pursued may be said to be almost a perfect one, and it has the merit of combining physical with mental training.

The entire course comprises six years, two of which are passed at sea, after a term of four years' study at the Academy. The entering cadet is termed a Fourth Class-man.

The final examination, at the end of this six years' course, if successfully passed, entitles the cadet to a diploma, but does not necessarily assure his being retained in the Naval service. According to a recent law of Congress, from each graduating class there shall be retained annually at least 15 cadets. Of these, 12 shall become Line Officers, two Engineers, and one a Marine Officer. In addition, there must also be kept as many of that class as will make the total number retained equal to the vacancies that have occurred in the several available corps during the preceding 12 months. In this way it may sometimes occur that an entire class of graduates will be retained, provided that the Navy, during the preceding year, has experienced that peculiarly sad fate so vividly portrayed in the Middie's toast, "A bloody war and a sickly season."

In case that the graduated cadet does not take a place sufficiently high in his class to fall within the number allowed to be retained for that year, he is honorably dis-

charged from the Naval service, and is allowed the sum of one thousand dollars with which to start in civil life.

The successful cadet, who takes a position within the number allowed, is at once promoted to the grade of Ensign, Assistant Engineer, or Second Lieutenant in the Marine Corps, the higher numbers in the class being allowed as far as possible to select the corps to which they shall be assigned. These naval grades correspond to that of Second Lieutenant in the military service. It will be noticed that this rank is attained in the Navy only after six years of service, while in the Army it is secured after a term of four years.

Vacancies in the Corps of Naval Constructors are filled by graduates of the Naval Academy, but only after these have been selected to serve a two-years' post-graduate course, that they may especially fit themselves for this duty. They are then appointed assistant constructors, and rank as naval lieutenants, junior grade, or with first lieutenants in the army.

The life of a naval cadet at the Academy is a busy one, and it is a mistake for any but youths of fine physique and strong determination of character to enter for the course. The study and work are exhausting, and often, after having pursued the course for some years, a candidate is rejected owing to a want of the physical force necessary to keep up with his class. It is in most cases not the brilliantly entering candidate who is finally successful in attaining the Ensign's commission, but the youth who enters possessed of strong perseverance and a determination to master the numerous and varied subjects which go to make up the academic course.

The curriculum comprises :

Seamanship, naval tactics, naval construction ;

Ordnance and gunnery (manufacture and use of guns, projectiles, armor, torpedoes, gunpowder, gun-cotton, fulminates, etc.);

Astronomy, navigation and surveying ;

Steam Engineering ;

Mathematics (arithmetic, algebra, plane, spherical, analytical, and descriptive geometry, trigonometry, differential and integral calculus) ;

Physics and chemistry (light, heat, magnetism, galvanism, electricity, etc.) ;

English studies (geography, grammar, history, rhetoric, composition, international law) ;

Modern languages (French and Spanish) ;

Physiology and hygiene ;

Sketching, topographical and mechanical drawing.

The drills and exercises consist of :

Naval tactics manœuvring ship, battalion, company and skirmish drill, boat-sailing, rowing, sail and spar exercises, light and heavy artillery fencing, swimming, boxing, dancing and athletics.

The time allowed for study and for drill is perfectly systematized, and is about the best method that could be devised for combining manual and mental training.

Each academio year is divided into two terms—one extending from October to February, and the other from February to June. At the close of the annual examinations, which are generally finished during the first week in June, the members of the undergraduate class are allowed to proceed to their homes for a short leave of absence, prior to being ordered for two years' sea-service aboard regularly commissioned vessels.

The newly promoted First and Third Classmen are sent to sea on a practice cruise, which each year extends through the months of June, July and August. The Second Classmen are required to remain at the Academy for the greater part of this time, in order that they may have exercise in Machine-shop work ; but all are allowed leave during the month of September to visit their homes—the three classes returning to Annapolis in time for the opening of the succeeding academic year, on or about October 1.

During these summer cruises ample opportunity occurs for exercise aloft at sail or spar drill, in all kinds of weather. The cadets are also taught to reef, steer, work the guns, heave the lead, and to practically navigate the vessel.

The undergraduate class, who have finished their four years' term of study at the Academy, now proceed to sea, being distributed among the several squadrons ; and at the end of two years are again ordered to Annapolis for a final examination, which determines not only whether they shall remain in the Naval service, but also establishes the relative rank of those so retained.

The various duties connected with the superintendence, instruction and drill of the Corps of Naval Cadets require the services of some 75 regular officers of the Navy, and about 18 Naval Professors.

## THE TRAINING SCHOOL FOR NAVAL APPRENTICES.

The school for the training of Naval Apprentices has its headquarters at Newport, R. I. There are several vessels assigned to duty connected with this institution—the *Richmond*, at Newport ; the *Minnesota*, at New York ; the *Portsmouth* and *Jamestown*, as cruising vessels, and one small schooner named the *Wave*.

The mode of obtaining admission to the Training School is simpler than that for entering the Naval Academy. The candidate is required to be over 14 and under 18 years of age, of good physique ; he must come voluntarily, and have the consent of his parents or guardian. A deposition to this effect is taken before a notary public by that person having control of the boy. The candidate, being physically qualified, is regularly shipped, or indentured, to serve the United States Government until he becomes 21 years of age, unless he shall be sooner discharged.

The system of education is entirely different to that pursued at the Naval Academy. This is carefully explained to the candidate before his entrance to the training school ; and that, as the Naval Academy is the only recognized channel-way by which he may expect promotion to the higher grades, if he elects to pursue the apprentice's course, he cannot expect promotion to a commissioned rank, except for special gallantry during war times, when such promotions are allowed.

It would not be fair to allow the students at the Training School to enter with the expectation of becoming commissioned officers, and then afterward require them to compete for their commissions with those who had received the advantages of a course in every way so much superior as is that furnished at the Naval Academy. On the other hand, it would not be reasonable to expect the Government to keep up two such institutions as the Naval Academy for the education of its commissioned officers.

Therefore, the entering apprentice, as well as his parent or guardian, are informed that the rank to which the boy can reasonably aspire is limited to one of those positions represented by a warrant, such as Boatswain, Gunner, Carpenter, Sailmaker, or Mate, unless, as before stated, he may, in time of actual warfare, receive a higher promotion, as a reward for conspicuous services.

When entered as an apprentice, the boy's education, while partaking of a practical rather than a theoretical nature, is yet such as to enable him to rise to a higher position in either the Navy or the Merchant Marine than he would do had he not had the advantage of this training. The school turns out excellent gunners, top-men, quartermasters, helmsmen, coxswains, etc.

The law now allows that there may be at one time in the service, either serving aboard regularly commissioned vessels or under instruction at the training school, 1,500 apprentices ; and therefore new enlistments depend upon the number who have lately completed their term of apprenticeship, or who, having been found incompetent or undesirable, have recently been discharged.

Great care is taken in the selection of the candidates for admission. It is specially explained to those applying that this school is not to be regarded as a house of correction—that there is no desire to have any but good boys, both physically and morally. As soon as it becomes apparent that a boy has been entered because he is worthless and unruly at home, he is discharged, and even though parents may at first succeed in deceiving the questioners, the bad traits of the boy, when they later appear, are always grounds for his immediate dismissal.

This extra care is not so much to save time or trouble to the Government in attempting to educate a worthless and unprincipled boy, as it is to prevent the introduction of immoral principles among the other boys who have been by their parents placed here to be honestly raised to manhood.

Dishonesty, lying, and insubordination are the three principal causes which generally lead incompetent parents to endeavor to have the United States Government provide their son with that moral training which they have been themselves unable to bestow.

When a boy, even though entered as an apprentice, is found to possess these vices—vices which are generally the result of a want of early training—he is discharged from the naval service, that he may not serve as a bad example for better raised boys to follow. His discharge recites the reason thereof; and thus it will be readily seen that it is not advisable to place dissolute boys here in the hope of having them "made into something," a task that the parents have neglected, or else have found already to be impossible.

When it appears that a boy, though unruly, is yet one of good spirit—whose traits, while mischievous, are yet not vicious; whose disobedience is only the outcome of an exuberant boyish nature, he is corrected with the light punishments which the Navy Regulations allow, and is generally brought to be an honest and obedient man. There is a marked difference between disobedience of orders and insubordination. Disobedience is or may be the result of a spirit of fun—a desire to have a good time. It may result from forgetfulness or carelessness. Insubordination is that malicious resistance to authority which it is the first principle of naval training to stamp out.

It would be going too far to assert that those persons who are sometimes disobedient are better than those who are always obedient; but if it were possible to fill our navy with absolutely obedient seamen and officers, it is doubtful if there would exist enough freedom of thought aboard to take a vessel into action and fight her guns, or to do anything else, in fact, except study how to refrain from breaking the regulations.

In other words, the fact that the regulations are being constantly broken demonstrates that they may be so infringed without serious harm to discipline. It is not of so much importance that we keep the regulations at all times intact, as it is that those who transgress the law are made to understand that punishment is certain to follow the *slightest* as surely as the *greatest* infraction.

"What is the use of temptations, if we don't yield to them?" has been asked by a prominent writer, and in a like manner we may inquire, How can we enforce our Navy Regulations if they are not transgressed?

It is needless to say, therefore, that while the discipline aboard of the training ships and in the regularly commissioned vessels is always strictly maintained, yet allowance is made in the punishments, when inflicted, by taking into consideration the age of the offender.

The sailor early sees that there are some regulations that he must break or else he will have a very slow time. He decides for himself, and when he does infringe the law, he knows that he will be punished. He also knows that aboard of a properly conducted ship the punishment that he then receives clears off his account with the Government for that offense.

When first enlisted, the apprentice generally serves some months aboard one of the larger training vessels, and there acquires the rudiments of his profession—knotting, splicing, stations of the top, gun's-crew, etc., and later becomes one of a "draft" sent to one of the smaller vessels, the *Portsmouth* or *Jamestown*, whose sails and spars are easier managed by boyish hands.

During the pleasanter months of the year these vessels are constantly cruising. They visit the West Indies, the Azores, Madeira, and are sometimes allowed to proceed as far as the mainland of Europe. The apprentices are taught reading, writing, arithmetic, geography, and history, and are, generally speaking, given the groundwork for a good education. In case that any boy desires to pursue the higher study of navigation, he will always find some one aboard who will furnish him this assistance gratis.

When first enlisted, the apprentice is allowed to draw from the ship's stores clothing and supplies to the amount of $45. He receives, from the date of his enlistment, pay at the rate of $9 per month, and is allowed one ration, which amply supports him. After having been some time aboard, he is examined for promotion to a higher grade, and if he shows certain improvement, he is rated as Second-Class Apprentice, and then receives $10 per month.

Later he is again examined, and if passed to the higher grade becomes First-Class Apprentice, receiving $11 per month. The next successful examination makes him a Seaman Apprentice, Second Class, with pay at the rate of $19 per month, followed later by examination and promotion to Seaman Apprentice, First Class, with pay at rate of $24 per month. These are the rates of pay which he may receive while serving his apprenticeship.

Each succeeding year, whether at the training school or serving on one of the regular stations, the apprentice is assigned to a more responsible position, and thus, while his education is progressing, he is also of decided advantage to the naval service.

As soon as he has been proved to have certain aptitude in drill and studies, he is chosen as one of a draft to a regularly commissioned vessel, and is there placed to discharge still more important duties. His studies do not cease when he has been ordered into the regular service; each vessel which carries apprentices is required by law to have among her complement a person rated as schoolmaster, and whose duty it is to give daily instruction to those of the crew who have not finished their term of apprenticeship.

The apprentice is discharged on the day that he becomes 21 years of age. Should he be serving aboard a vessel on a foreign station he must be ordered to the United States in time to arrive and be discharged on that day.

He is then free to re-enlist or not, as he may choose. If he desires to remain in the Navy, he declares his intention of so doing; and then, if he signs the shipping articles at any time within the next 90 days, three months' pay is added to his accounts, and he receives one dollar per month in addition to the monthly pay of his rating, this being for what is known as "continuous service."

The constant drill, healthy fare, regular hours, and systematic training tend to develop the naval apprentice into a strong and hearty man; and though he may not choose to remain in the Navy, he is yet generally sure of a good place in the Merchant service or aboard of some yacht, etc.; and those so employed are always available in time of war, as a source from which to obtain seamen well drilled in the military part of their profession.

It is hardly to be expected that the majority of these will re-enlist in the Navy, so long as there exist outside more lucrative positions with easier hours of duty. But it cannot be considered that the benefits of the training school are lost, simply because an apprentice chooses to accept a better paying position elsewhere—a position generally secured by him wholly on the strength of his naval education.

During the year ending June 30, 1889, there were 2,738 applicants for enlistment as apprentice. Of these only 892—less than one-third—were found physically and morally qualified, and only 698—about one-fourth of the number of applicants—were finally admitted as apprentices. These figures show conclusively that the Navy Department does not intend to give this naval training haphazard, but only to persons who are able and willing to make good sailors of themselves, and be a credit rather than a disgrace to the service which has trained and educated them.

There are employed in connection with the training school and its cruising vessels about 60 officers, and perhaps 400 petty officers and seamen.

Notwithstanding the difference in their systems of education, yet in both schools there are certain principles of teaching which are common. Discipline is the same at each institution. The youth, be he under instruction for the position of commissioned officer or for that of seaman, is taught that, before he may expect to be placed in command of others, he must himself learn to obey.

Fine seamen can always be made out of those youngsters who live near the wharves of our sea-board cities—those boys who are always seeking the chance to sail a boat or row a skiff, and who are naturally born watermen. Such a boy knows from the start that going to sea is

hard work, and not at all times the poetry that it has been so glowingly depicted by novelists. He knows that he may be sometimes ordered to "lay out" upon an ice-laden yard and furl a frozen sail; to "turn out" from his warm bed at midnight, to keep a sleepless watch in inclement weather—to go for days with nothing but salt food, etc.; and when these episodes in his seafaring life occur, he does not regard them as impositions, but as a matter of course.

It is preferable that, instead of leaving a comfortable home with loving and attentive parents, the boy be one who is seeking to make a home for himself; and such a home he finds aboard of one of our naval vessels.

When he comes ashore, you can generally distinguish the thorough sailor by his uncertain attitude as he walks the street, "taking bearings" alternately on the houses and the street car tracks. Quite different is the appearance of this same man when you find him on his native heath, the deck of a ship! With half an eye he sees the disarrangement of some insignificantly small rope-yarn, or a minute pleat in the furling of a sail. Not only does he see this, but his quick mind knows at once the remedy for the defect that he has discovered.

This is one of the earliest principles learned by the practical sailor—either officer or seaman—not to spend his time unearthing faults, unless he can show remedies for the same. The sea-lawyer, with his grumbling, growling and discontent, is rapidly becoming a thing of the past. The sailor of the present day finds faults—possibly as many now as formerly, but in a more reasonable way; and nine times out of ten can show that he has good theories as to how they should be remedied.

The best sailor is that man who lives for the sea—who regards the ocean as a part of his own particular birthright, and who thinks that, as the sea belongs to him, he therefore has not possibly as good a right ashore as the "land-shark," who so constantly fleeces him.

The moment he sets his foot aboard ship he feels a sense of relief, and commences to "put things to rights." It becomes second nature to the seafaring man to "put things to rights." This trait is born of the necessity of keeping everything in a small space.

It is noticeable that when a vessel of war is sent alongside the dock to be placed out of commission, the contents of the several holds and magazines form a pile twice or thrice the size of the vessel which contained them; yet this represents only her unexpended stores and ammunition. As we regard this pile we realize that nothing but the most exact stowage could replace it in the vessel.

So particularly is this exactness of stowage required that the business of stevedore, or stower, has become a profitable calling, and there are stevedores who can by the eye better estimate cubic space than a less experienced person would do with tape-line or yard-stick.

Every sailor becomes to a certain extent a stevedore; and it is not alone the man on the berth-deck who learns by experience to make the most of the "room and space" allowed him by the Government. The contents of a sailor's clothes-bag would astonish the landsman, who has all his life considered it necessary to have one or two trunks for his wearing apparel. A "Ditty-box," filled with articles of all description, ranging from ink and shoe-blacking to postage-stamps and skeins of the most delicately tinted silk floss, would, from the exactness and care with which each article is kept, excite the admiration of the most particular housewife.

Having thus to stow his worldly belongings in the smallest possible compass, the sailor early forms the habit of setting anything to rights that he may notice to be out of order. In fact, so noticeable is this trait that even landsmen themselves allude to "getting everything *ship-shape*."

On one occasion, during quite a spirited quarrel which took place between two sailors, owing to too much alcoholic stimulation, the liveliest part of the row occurred when, being called upon to desist and "go to the mast," the combatants were not allowed the requisite time to replace two belaying pins which had been called into use during the *mêlée*.

(TO BE CONTINUED.)

## ELECTRICITY FROM WIND POWER.

From the very moment that the storage battery became a practical, commercial apparatus its application to the storage of energy derived from the power of the wind was broached, but up to the present time very few attempts have been made to carry out the suggestion in practice. Our readers will therefore be interested in the plant operated by Mr. C. F. Brush, for several years at Cleveland, O. When we consider the widespread application of wind power to the operation of pumps for elevating water it seems indeed strange that no determined effort has been made to apply the same power to the storage of electrical energy. In the latitude in which we live steady winds may be counted on for the largest part of the year, so that the only remaining objection would be the cost of a windmill storage plant. We can readily conceive that a single pioneer plant, such as that of Mr. Brush, might involve considerably more expense than a second or third of the same nature, and, again, that the average plant would not require to be nearly as large. It therefore seems pertinent to suggest that this field so entirely unoccupied at the present time be seriously considered, as we are certain that a profitable if not a large business can be developed in this direction.

Electricity is already utilizing thousands of horse-power from watercourses, and is preparing for even more extensive work at Niagara, and there seems no good reason why it should not utilize the wind. We hear of plans now and then for getting something electrically out of the sunshine and the tides, but while that may be a remote result, it should be easy enough to transform the power of rising winds and falling waters.—*Electrical Engineer.*

## THE TRANS-SAHARAN RAILROAD.

(From the *Bulletin* of the International Railroad Congress.)

The question of the Trans-Saharan Railroad has been submitted by the French Government to a Commission, at the head of which is M. Alfred Picard, President of the Section of Public Works. Three lines have been submitted to this Commission; they are indicated on the accompanying sketch map. These lines are as follows:

1. The Western Line, explored by MM. Mauger and Fousset, which starts from the terminus of the Oran Rail-


road at Ain-Sefra, Algeria, and runs by way of Insalah to Timbuctoo, following as nearly as possible the line of the

oases. A branch to Bouroum, with a possible extension to Lake Tchad, is proposed. The distance is 1,240 miles to Timbuctoo; the branch to Bouroum is 435 miles.

2. The Central Line, advocated by General Philebert and M. Roland, which starts from the East Algerian Railroad at Biskra, runs through Onargla, Timassinin and Amguid and divides at Haggar, one branch running to Bouroum and the other to Lake Tchad. The length is 1,620 miles to Bouroum; the branch to Lake Tchad, 620 miles.

3. The Eastern Line, starting from Gabes, running through Ghadames and joining the Central Line at a point about 330 miles from the starting-point.

A line starting from Cape Nun has been proposed, and also one from the extreme west of Algeria, but these are not seriously advocated.

In connection with all the lines a road from the port of St. Louis on the west coast through Timbuctoo and Bouroum to Kouka on Lake Tchad is proposed.

The choice of the Commission will, of course, be influenced by political and military considerations. Thus for the western line the occupation of Insalah would require a serious campaign, while the adoption of the eastern line would involve difficulties with Tripoli. On the central line it would be necessary to establish small colonies at a few points, with military posts at Timassinin and Amguid; the latter is an important commercial point and a central post from which the Touareg tribes could be controlled. For these reasons the central line will be recommended.

It was originally proposed to build a narrow-gauge line on the Decauville system, but it now seems probable that a meter-gauge road with 45-lbs. rails will be recommended. The cost is estimated at a low figure, about $16,000 per mile, as no large bridges or expensive works will be needed.

## ARMY ORDNANCE NOTES.

THE bids were opened January 5 at the Ordnance Office of the War Department for making 100 guns, which have been authorized by acts of Congress. Two bids only were received, each being considerably over the amount of the available appropriation, which is about $3,500,000. The first bid was from the Midvale Steel Works, of Philadelphia, and was in substance as follows: 8-in. guns, 25, for $22,028 each; 10-in. guns, 50, for $51,880 each; 12-in. guns, 25, for $88,592 each; the total bid amounting to $5,359,500. This Company offered to deliver one gun of each type within three years, and the remaining guns within eight years from the acceptance of the type guns. This would carry the last delivery over to 1901.

The second bid was from the South Boston Iron Company, of Boston, which has recently established new works in Kentucky. This Company offered to furnish the guns as follows: 8-in. guns, a type gun for $20,300 by January 1, 1893, and the remaining 24 at $20,995 each, to be delivered at the rate of six per year; 10-in. guns, a type gun for $46,560 by June, 1893, and the other 49 to be delivered at the rate of five per year and at the price of $48,000 each; 12-in. guns, the type to be ready January 1, 1894, and to cost $76,800, and the remaining 49 to be delivered at the rate of three per year after 1894, and to cost $79,200 each. In all cases 10 rounds of ammunition were included with each gun.

The South Boston Iron Company also submitted an alternate proposal to the effect that the firm would furnish the 100 guns for the amount stated by the Chief of Ordnance as the cost of the work at the Watervliet Arsenal, and in the same time as they could be furnished from there.

If General Benet's plan for completing the gun factory at Watervliet were carried out, the 100 guns could be produced by 1897, or within about six years from the present time. The cost would be somewhat greater, but the Government would have in hand one of the finest gun-making plants in the world, besides the guns. On the other hand, it would certainly be a great advantage to the Government to encourage the building up of private plants which would be able to furnish guns of the largest size when called upon in case of war or other emergency which may happen.

## THE DEVELOPMENT OF THE COMPOUND SYSTEM IN LOCOMOTIVES.

By M. A. Mallet.

(Paper read before the Société des Ingenieurs Civils, Paris; translated from the French by Frederick Hobart.)

AT the end of 1877, when I had the honor of treating the question of Compound Locomotives before your Society for the first time, there were only three locomotives of that kind in service and nine under construction, and these machines were all of small dimensions and upon roads of minor importance. At that time also the probable advantages of the compound system as applied to locomotives were not only generally contested, but many engineers were even unwilling to admit that the question presented any practical interest at all, their objections being based upon theoretical and practical considerations. To make the contrast more striking, I may say that at the Exposition, in 1878, in Paris, there was a single compound locomotive shown by myself, chiefly for the purpose of making a point or a date for the invention, and under the conviction that a much better showing would be made at the next Exposition.

Let us see if my conviction has been supported by facts.

At the last Exposition there were 15 compound locomotives; some exhibited in the galleries and others in service on the Exposition Railroad; and more than half of these belonged to the type devised by myself.

It will no doubt be a surprise to many to learn that there are now nearly 1,000 compound locomotives actually in service. In the report of Chief Engineer Parent on the Exposition, presented to the International Railroad Congress, tables were given estimating at 680 the number in service in June, 1889, more than 400 of these having been built within four years. This figure is below the real number. On two lines alone—the Northeastern in England and the Prussian State—over 150 compound engines have been put in service since this report was made. If we add the number in other countries, such as Russia and the smaller German States, we increase the number to over 900, divided between 70 or 80 roads, and there is no doubt that this is increasing very rapidly and will increase much faster, especially as the question has been taken up in the United States recently for the first time, and will doubtless be attended to with the energy and the decision which characterizes that country.

It may be said that I am exaggerating the importance of this question, since even this figure would not represent more than 1 per cent. of the total number of locomotives in the world. Nevertheless, even should the progress of the double-expansion engine be arrested instead of continuing to increase, this figure is much above the total which was attained by special systems which were considered very successful in their day, such as the Crampton, the Engerth and others.

Not only have distinguished engineers supported the compound system in the most efficacious manner, by adopting it, but many who were first opposed, better becoming informed or enlightened by experience, now advocate it and consider that it will take a more and more important position in railroad economy.

Railroad companies and the engineers in charge of their motive power may be, in fact, divided on this question into three classes: Those who have not tried the compound system; those who have it under trial, and those for whom the period of trial is passed.

The first class hardly needs further consideration.

The second class includes those lines where the system has been applied on a limited scale, in order that its advantages and disadvantages may be ascertained by actual experience. In this may be included all those lines which have less than 10 engines of this class, with the exception noted below.

The third class is that where the new type of locomotive may be considered as definitely adopted for a part or a whole of the motive power, whether this adoption has been based on actual experience on the road, or from results

obtained on other lines. We have included in this class those roads which have more than 10 compound engines, and also those which have less than 10, provided they are small lines on which that number would constitute a large proportion of the engines.

The first class is and will remain for some time the most numerous, but the second already exceeds 50, and the number is being every day increased, while the third now includes 25 companies, most of them of considerable importance. Among these may be numbered the Northeastern in England, which at a late date had 194 compound engines, 32 being in passenger and 162 in freight service; the London & Northwestern, which has about 100, nearly all passenger engines; the Prussian State Railroad, which on its Bromberg, Hanover, Frankfort & Magdeburg and Cologne Divisions has 205; a line in the Argentine Republic, which has nearly 50, and the Saxon State Railroad, over 40. The Vladicaucasus Railroad in Russia has ordered the change of all its locomotives, about 30 in number, to compound engines. This enumeration might be lengthened, but it is perhaps enough to say here that all the service of the Exposition Railroad in 1889 was performed by compound locomotives.

In the presence of these facts, it is impossible to deny that the compound locomotive is now a practical question in railroad operation, and that it can no longer be considered as merely an experiment. The objections which have been made to it by many engineers will be examined in detail later in this paper. It is enough to say here that there is no longer any doubt that its introduction marks the most important improvement in the locomotive of recent years; from my point of view the most important which has been made since the locomotive first assumed a practical form in 1829. Certainly, if it has done nothing else, it has caused discussion, investigation and experiment, which may lead to the attainment of the same end by other means.

It may be well here to give some account of the different types of compound locomotives so far built, and it seems best to continue the method of classification adopted in that original paper in 1877, and based upon the number of cylinders. I will commence with those of two cylinders, which were the first construction, and are at present much the most numerous. In the accompanying table I have collected the most important elements of 50 types of compound locomotives with two, three and four cylinders, which may be convenient for reference.

### TWO-CYLINDER COMPOUND ENGINES.

In my first paper I said that the application of the compound system to the locomotive could be realized by the use of two cylinders working on cranks placed at right angles, and having between them a receiver of considerable capacity, and provided with a special apparatus permitting the engineer to make at will the working of each cylinder direct and independent of the other. This arrangement has met with many objections, but has succeeded in practice, and I believe that its use is limited only by the dimensions which can be given to the larger cylinder.

It may be interesting to note that the first mention of the use of two cylinders of different diameter for the locomotive dates back to the invention of the Wolff compound engines with an intermediate receiver. In fact, in a patent taken out in France, in February, 1834, by Köchlin & Company, of Mulhouse, an invention patented on account of the Dutch engineer Roentgen, who was the true inventor of the compound engine, we find the following phrase, which follows an account of the convenience of the use of the two cylinders on the Wolff system, acting on cranks placed at right angles, for steamboats—where such an arrangement would not require any more complication than the ordinary two-cylinder engine—"the same advantages will be found in the application of this system upon railroads." It is not less interesting to note that this phrase is not found in the English patent taken by Ernest Wolff, as representative of Roentgen, the text of which is otherwise almost identical with that of the French patent, and which is accompanied by the same drawing. Now it can hardly be said that the locomotive had less interest in 1834 in England than in France, and it is reasonable to suppose that the introduction of the sentence quoted in the French patent was due to Köchlin & Company, who, struck by the simplicity of Roentgen's statement, at once foresaw the ease with which it could be applied to locomotives, in the manufacture of which those eminent builders already anticipated great success.

Certainly there is no reason to exaggerate the importance of this simple mention made at the time when locomotives worked at a comparatively low pressure, but it is very interesting to know that this application of double expansion had been already indicated even before it had become common to use the expansive force of steam in a single cylinder, since at that time it was customary to admit steam for 90 or 95 per cent. of the stroke.

From 1834 we must go to 1850 to find an attempt to modify the ordinary method of working steam in locomotives. This is found in the system of *continuous expansion* patented in England by Samuel & Nicholson, which now forgotten, or considered only as a historical curiosity, has, since the success of the two-cylinder compound locomotive, been presented by many English authors as the first attempt at the application of the compound principle to the locomotive. It is to be regretted that some French writers have seemed to accept a claim which can only be based on a very slight knowledge, to say the least, of the principle of Nicholson's machine. It is enough to say that the continuous expansion system is not a derivation from the Wolff system, but, on the contrary, a deviation from it, as can easily be shown.

Two engines were arranged on this plan on the Eastern Counties Railroad, in England, one retaining the old cylinders, the other being supplied with one new cylinder of a capacity double that of the old one. The arrangement of the passages between the cylinders was such that live steam reached the first cylinder alone during about half of the stroke. At that point a direct communication was opened between the first cylinder and the second, the piston of which was at the dead point. The expansion was thus made simultaneously in the two cylinders up to the end of the stroke of the first one, which then commenced to exhaust directly into the air, while the expansion of the steam contained in the second cylinder continued until the end of its stroke. It is easy to say that with this system each cylinder had to submit to the almost complete fall in pressure and temperature, which the use of the compound principle, by dividing the expansion between the two cylinders, seeks to avoid as an essential object. The claim made by Mr. Samuel in the paper from which we quote was that *a part* of the steam discharged into the chimney to improve the draft in ordinary locomotives could be reserved for a further degree of expansion, and that the economy of the system of continuous expansion came from the part thus reserved for the purpose of utilizing its total capacity, which was lost in ordinary engines. He further stated that from one-half to two-thirds of the steam admitted was discharged from the first cylinder directly into the stack to secure the draft, the rest being carried to the second cylinder to be there further expanded and furnished additional work.

It will be seen at once that this is not at all the method of action of the compound locomotive, where *all* the steam which enters the first cylinder passes into the second, and where the draft is produced entirely by the steam escaping from the latter. In fact, the only reason which can be alleged for the continuous expansion arrangement is that the steam escaping from a single cylinder would not be sufficient to maintain the proper draft for the locomotive boiler. In figs. 1 and 2 we give a sketch showing the general disposition of the continuous expansion engine, as shown by the drawings annexed to Mr. Samuel's paper submitted to the Institution of Mechanical Engineers. We have done this in order to show the vital differences between it and the compound system, which is much the more simple. This is still further shown by fig. 3, in which the indicator diagrams of the two cylinders of the compound engine can be placed one above the other and combined in such a way as to show the manner in which the steam works successively in the whole apparatus. This cannot be done with the continuous expansion engine, where we

must limit ourselves to placing one diagram beside the other, since the expansion of the steam is there for the most

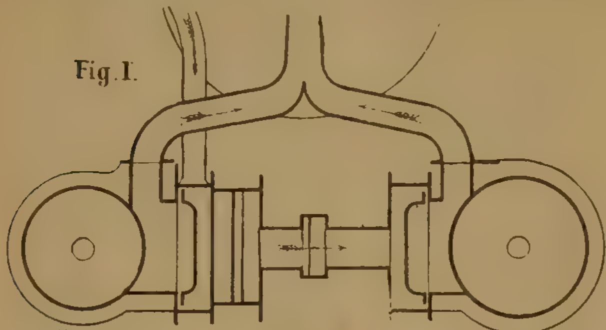


Fig. I.

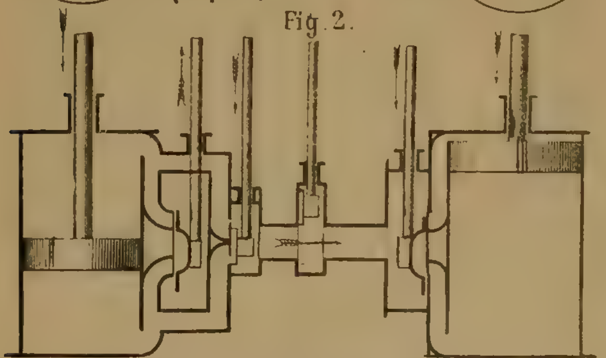
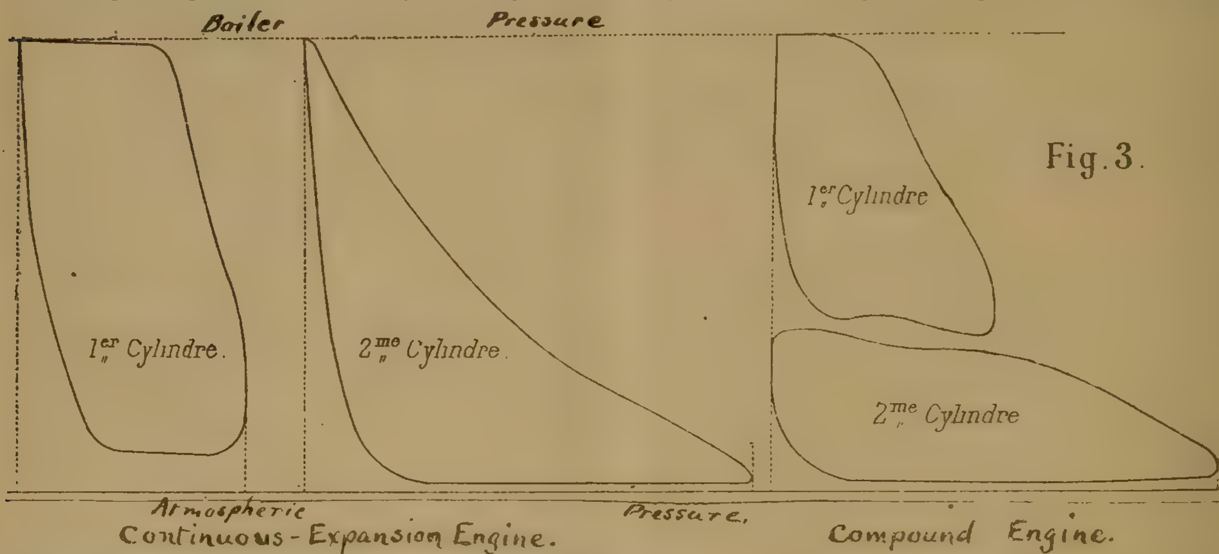


Fig. 2.

part simultaneous. This discussion might be continued much further, but sufficient has been said to dispose of the claim that it constituted the first invention or application of the compound principle. It is only necessary to add




that Mr. Nicholson, in a public letter, protested against comparing his system to that of Wolff, alleging against the latter the drawback that the pressure upon the larger piston was really a counter-pressure upon the small one.

In 1874 we commenced to call attention to the ease with which the compound or double-expansion principle could be applied to locomotives without complication under the ordinary arrangement of two cylinders, and the first manager who was impressed with this principle was Monsieur Eugene Pereire, President of the Compagnie Générale Transatlantique, who was then occupied in building the Bayonne-Biarritz Railroad. An order for three compound locomotives for this road was given to the Creusot Works in 1875, and the first one was tried in 1876. Here was the real beginning of the compound locomotive.*

Since this engine—No. 1 on the table—contained all the essential arrangements, valves, receiver in the smoke-box, etc., and the 750 two-cylinder compounds now existing differ from it only in simple modifications of detail, it may be well to say that these engines were not in any manner ordered on account of experience, as some authorities have said. The Bayonne-Biarritz Company had no means of making any experiments, and these engines were ordered after mature reflection and a careful study of the principle, without hesitation and with a certainty of success which never wavered for an instant. The three engines which were so ordered have been in existence for 14 years, and for 13 of them in regular service on the line, where, aided by two other compound engines of greater power, built in 1878, they have run up to the present time a total of nearly 1,000,000 miles without showing any weak point either in principle or in construction.

The name of this little road is therefore an important one in the history of the compound engine, and will always figure in that of the progress of the locomotive.

The decisive success of these machines led rapidly to new applications of the principle, either by the building of new engines of small dimensions, or by the change of existing engines of larger size. The latter, however, at first had only moderate success, and it may be well to refer to this here, partly in order to correct some mistaken statements which have been made, and partly because some important conclusions may be drawn from this experience.

The management of a test of the comparative consumption of locomotives is always a delicate matter, which should be undertaken with many precautions. The general arrangement is to make the engines work for a certain time with ordinary locomotives, putting them as much as possible under similar conditions. The consumption of fuel and the loads are carefully ascertained, and at the conclusion of the trial the result is given, which very probably is that the new system is ingenious and well devised, but has not given the advantages hoped for. In a word, the affair is judged and settled.

Often, however, the result really depends upon some little detail, which is entirely apart from the principle of the device tried. Many examples might be given, but perhaps one or two may be enough. In 1877 one of the engines from the Bayonne-Biarritz Line was tried on a branch of the Orleans system with an ordinary locomotive of about the same power, and on the first trial the results obtained were unfavorable, the compound engine consuming about 7 per cent. more fuel than the other. Upon examination it was found that the coal used was entirely different from that for which the grate of the compound had been made, and the consequence was that over one-third of the coal fell through the grate into the ash-pan without being consumed at all. A second trial being made, with proper changes, showed an economy of 31 per cent. in favor of the compound. At another trial on the Montereau Line the compound showed a saving of only 1.2 per cent., but

* It may be stated that the claim has recently been made that a compound engine was used on a steam passenger car on the Worcester & Shrewsbury Railroad, in Massachusetts, about 1860, but of this fact M. Mallet was probably not aware.

the engineer of the line, noting some points which he did not exactly understand, made a careful examination, and found that the compound engine did not have sufficient draft. On reducing the size of the exhaust nozzle and making some slight changes, a saving of 20 per cent. was realized.

These examples show once more the fact that in testing a machine it is absolutely necessary to eliminate as far as possible all disturbing circumstances outside of the single point under investigation.

The engine uses the steam which the boiler produces by the combustion of coal upon the grate. The motive power is thus obtained by a series of distinct operations, and to judge of any one of them by the final gross result is an elementary method which may lead to very erroneous conclusions. I do not seek to prove by this that all the trials which had not the most favorable results for compound engines were necessarily badly conducted, but simply to recall the fact that it is necessary to look twice before concluding for or against a new system, especially upon a few experiments. A hasty judgment is rarely final, and if it is flatly contradicted by later experience, such a result is not flattering to the first judges.

In 1878 a passenger engine on the Orleans Railroad was changed to a compound, by replacing the right-hand cylinder by a new one 21.65 in. in diameter, the other being 16.54 in. In this case the new cylinder was the largest that could be put in without making extensive changes in the engine, and was really too small in relation to the other. Moreover, this engine was, for the most part, run in connection with ordinary locomotives having cylinders 17.32 in. in diameter, and the alteration was so made that it was impossible to admit live steam from the boiler to the low-pressure cylinder directly. The boiler pressure also was not as high as it is customary to use in engines of later construction. Under all these circumstances, a favorable result was hardly to be expected, but this engine proved one important point, and that is, that the objections of additional repairs, loss of time, and mileage, etc., which have been urged against the compound, were without foundation. In a little less than three years, from October, 1878, to July, 1881, the engine had run about 60,000 miles. Results not altogether favorable were also obtained with an engine on the Kaiser-Ferdinand Northern Railroad in Austria, which was altered in somewhat the same manner. The objection made in this case was that too much force was exerted upon the large piston, which led to the racking and injury of the engine. It seems, however, that this might have been avoided by applying a reducing valve, or by a better arrangement of the throttle.

The apparent results of these trials were that the principal difficulty was the high degree of compression produced in the smaller cylinder at certain degrees of admission, but it does not seem that any effort was made in any way to prevent this compression. A change in the valve of the smaller cylinder would probably have been sufficient to improve very much the conditions of working, but in both cases the system was condemned without close examination, or without any attempt to improve it.

To these trials, however, only a very moderate degree of importance was attached because a test had been elsewhere under very different conditions, which had an important influence on the future of the compound locomotive. We refer here to a change made in 1879 by M. De Borodine on a passenger engine of the Southwestern Railroad in Russia. The change was made on plans furnished by myself, and the trials were conducted with great care and precision. This trial was followed by others, and led finally to the distinct adoption on the Russian State Railroads of the principle of double expansion, which is now required by the chief administration for all new engines.

In 1880 M. Von Borries, Superintendent of Motive Power of the Hanover State Railroads, encouraged by the success of the engines of the Bayonne-Biarritz Railroad, applied the compound principle to two four-wheel engines, which were used in local service, and which were built by Schichau at Elbing. His object was to do away entirely with the direct admission of steam to both cylinders, and to have the engine always worked as a compound in order to avoid some inconveniences, the importance of which he exaggerated very much. In these first machines the throttle valve was arranged in such a way as to send, when it first opened, live steam from the boiler to the intermediate reservoir, but to close this passage when it was further opened. These engines, in comparison with others previously used, which were exactly the same, with the exception of the compound arrangement, showed an economy of 20 per cent., which led the management to extend the application of the principle. The starting devise, however, did not give good results, and Mr. Von Borries changed it several times before reaching his present arrangement.

The next machines were two locomotives of about 38 tons weight with six-coupled wheels, followed in 1884 by several passenger engines.

In 1884 Mr. Worsdell applied the compound system in the same form to an express engine on the Northeastern Railroad, in England, which had cylinders 18 and 26 in. in diameter and 24 in. stroke, and driving-wheels 7 ft. in diameter. The starting arrangement was very similar to that of Mr. Von Borries, and an apparatus of this description, known as the Worsdell-Von Borries system, was ap-

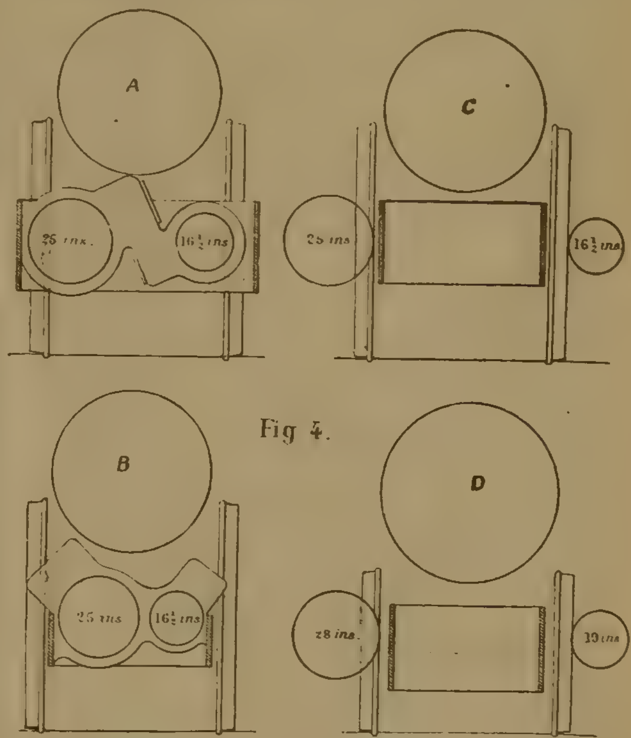



Fig 4.

plied to a large number of two-cylinder locomotives built for different lines in Europe, South America and British India.

While I admit the important services of Mr. Von Borries in introducing the compound engine, I hardly think that his friends have been justified in establishing a certain confusion between the automatic starting apparatus and the two-cylinder compound engine itself. This has been done by a number of English and German writers, but the fact is that if the two-cylinder compound engine is used, it is because it gives economical results with the least possible complication. Now these, especially the former, do not depend in any way on the use of a particular form of throttle valve. In fig. 4 there are reproduced four plans presented by myself before the Institution of Mechanical Engineers in London for compound engines, *A* and *B* being for inside-cylinder passenger engines; *C* for an outside cylinder passenger engine, and *D* for the outside cylinder freight engine. These arrangements are identical, even the proportions being almost the same as those which were used several years later in locomotives recently called the Worsdell-Von Borries. That name should really be applied only to the throttle valve arrangement.

M. Von Borries has also sought to present his engine as

## TABLE OF DIMENSIONS OF FIFTY COMPOUND LOCOMOTIVES OF DIFFERENT TYPES.

| No. | Railroad Line. | System. | Builders. | Date of Construction. | Gauge of Road. | No. of Wheels. Total. | No. of Wheels. Coupled. | Grate Surface. | Heating Surface. | Working Pressure. | Diameter of Small Cylinder. | Diameter of Large Cylinder. | Ratio of Volumes. | Stroke of Pistons. | Diameter of Drivers. | Weight. On Drivers. | Weight. Total. | Tractive Effort. | Proportional Volume of Expansion. | Volume of Expansion Reduced to Uniform Pressure. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Two Cylinder Type.** | | | | | | | sq.ft. | sq ft. | lbs. | inches | inches | | inches | inches | lbs. | lbs. | kilog. | | |
| 1 | Bayonne-Biarritz.... ... | Mallet...... | Cr'us'tW'ks | 1876 | 4' 8½" | 6 | 4 | 10·76 | 485 | 142 | 9·45 | 15·75 | 1:2·78 | 17·72 | 47·25 | 31,960 | 39,672 | 1,080 | 4·14 | 4·14 |
| 2 | " " ......... | " ..... | Passy W'ks. | 1878 | 4' 8½" | 6 | 6 | 13·56 | 610 | 142 | 11·02 | 16·54 | 1:2·25 | 21·65 | 47·25 | 48,488 | 48,488 | 1,795 | 3·67 | 3·67 |
| 3 | Haironville-Triancourt... | " ..... | " " | 1877 | 1m't'r | 6 | 6 | 6.99 | 351 | 142 | 8·66 | 13·58 | 1:2·53 | 15·75 | 29·52 | 31,960 | 31,960 | 1,290 | 4·38 | 4·38 |
| 4 | Orleans*............. .... | " ..... | Co.'s Shops. | 1878 | 4' 8½" | 8 | 4 | 17·44 | 1,464 | 121 | 16·54 | 21·65 | 1:1·71 | 25·59 | 78·74 | 49,150 | 84,200 | 2,366 | 4·41 | 5·38 |
| 5 | Spanish Northern*........ | " .... | " " | 1878 | 5' 6" | 6 | 6 | 14·28 | 1,191 | 100 | 17·32 | 23·62 | 1:1·85 | 23·62 | 51·18 | 71,630 | 71,630 | 3,123 | 5·10 | 7·29 |
| 6 | Southwest Russian, pass.. | " .... | " " | 1879 | 5' 0" | 6 | 4 | 15·70 | 1,126 | 128 | 16·54 | 23·62 | 1:2·04 | 23·62 | 66·93 | 58,400 | 79,350 | 2,802 | 4·79 | 5·32 |
| 7 | " " frt.... | " ... | " " | 1887 | 5' 0" | 8 | 8 | 23·68 | 1,346 | 128 | 19·69 | 27·05 | 1:2·01 | 25·50 | 51·18 | 103,600 | 103,600 | 5,625 | 5·36 | 5·95 |
| 8 | Athens-Laurium...... .. | " ..... | Kessler..... | 1883 | 1m't'r | 6 | 6 | 8·93 | 518 | 142 | 12·60 | 18·90 | 1:2·25 | 20·87 | 35·43 | 56.200 | 56,200 | 3,020 | 5·32 | 5·32 |
| 9 | Jura-Simplon*........... | " .... | Co.'s Shops | 1888 | 4' 8½" | 6 | 6 | 14·64 | 1,437 | 142 | 17·72 | 25·59 | 1:2·08 | 25·59 | 51·57 | 79 800 | 79.800 | 5,022 | 5·78 | 5·78 |
| 10 | Austrian State* .... .... | " ..... | " " | 1889 | 4' 8½" | 8 | 8 | 21·11 | 2,017 | 142 | 18·60 | 26·18 | 1:2·00 | 24·88 | 46·65 | 102,500 | 102,500 | 5.898 | 5·07 | 5·07 |
| 11 | " " *........... | " .... | " " | 1889 | 4' 8½" | 6 | 6 | 18·90 | 1,292 | 142 | 16·58 | 23·62 | 1:2·03 | 24·88 | 49·76 | 77,140 | 77,140 | 4,430 | 5·14 | 5·14 |
| 12 | French State*............ | " .... | " " | 1888 | 4' 8½" | 6 | 6 | 12·92 | 1,084 | 128 | 16·54 | 23·62 | 1:2·04 | 23·62 | 59·45 | 73,850 | 73,850 | 3,151 | 4·27 | 4·74 |
| 13 | High Speed, proposed..... | " .... | ............. | 1889 | 4' 8½" | 8 | 4 | 21·53 | 1,292 | 170 | 21·26 | 31·89 | 1:2·25 | 24·02 | 84·65 | 66,120 | 110,200 | 5,028 | 6·10 | 5·10 |
| 14 | " " " .... | M'l't-Br'n'r | ...... .... | 1889 | 4' 8½" | 8 | 4 | 24·22 | 1,722 | 170 | 20·47 | 31·10 | 1:2·30 | 24·02 | 78·74 | 66,120 | 110,200 | 4,948 | 6·34 | 5·29 |
| 15 | Prussian State, local service | Von Borries | Schichan... | 1881 | 4' 8½" | 4 | 2 | 8·61 | 371 | 170 | 10·60 | 16·54 | 1:2·40 | 16·54 | 44·49 | 24,500 | 44,000 | 1,627 | 6·19 | 5·16 |
| 16 | " " freight ... | " " | Henschell.. | 1883 | 4' 8½" | 6 | 6 | 16·04 | 1,332 | 170 | 18·11 | 25·59 | 1:2·00 | 24·80 | 52·36 | 84,850 | 84,850 | 6,018 | 5·20 | 4·33 |
| 17 | " " pass....... | " " | " . | 1883 | 4' 8½" | 6 | 4 | 18·84 | 1,055 | 170 | 16·54 | 23·62 | 1:2·04 | 22·83 | 68·11 | 57,300 | 83,750 | 3.546 | 4·64 | 3·86 |
| 18 | Alsace-Lorraine, pass..... | " " | " .. | 1889 | 4' 8½" | 6 | 4 | 16·47 | 944 | 170 | 14·57 | 21·65 | 1:2·22 | 19·69 | 59·05 | 57,300 | 76,900 | 2,735 | 3·87 | 3·22 |
| 19 | Saxon State, express...... | Lindner.... | Chemnitz... | 1886 | 4' 8½" | 6 | 4 | 19·59 | 1,098 | 170 | 16·54 | 25·59 | 1:2·40 | 22·05 | 73·82 | 63,250 | 91,250 | 3,016 | 4·38 | 3·65 |
| 20 | " " pass ........ | " .... | " ... | 1889 | 4' 8½" | 6 | 4 | 19·59 | 1,044 | 170 | 16·54 | 25·59 | 1:2·40 | 22·05 | 62·42 | 60.200 | 89,300 | 3,670 | 5·55 | 4·62 |
| 21 | " " freight..... | " .... | " ... | 1885 | 4' 8½" | 6 | 6 | 15·18 | 1,238 | 170 | 18·11 | 25·59 | 1:2·00 | 24·02 | 54·72 | 92,600 | 92,600 | 5,567 | 4·42 | 3·69 |
| 22 | Bavarian State, pass.. ... | " .. | Krauss.... | 1890 | 4' 8½" | 6 | 4 | 20·34 | 1,191 | 170 | 16·93 | 24·02 | 1:2·00 | 24·02 | 73·23 | 63,900 | 93,650 | 3,639 | 4·21 | 3·51 |
| 23 | " " freight.... | L'dn'r-Kr'ss | " .... | 1889 | 4' 8½" | 6 | 6 | 17·87 | 1,355 | 170 | 19·14 | 27·76 | 1:2·10 | 24·80 | 52·36 | 90,350 | 90,350 | 6,717 | 5·74 | 4·78 |
| 24 | " " local... . | " " | " .... | 1890 | 4' 8½" | 8 | 6 | 13·99 | 782 | 170 | 14·17 | 22·05 | 1:2·40 | 19·69 | 42·91 | 59,500 | 74,700 | 3,844 | 5·33 | 4·44 |
| 25 | Wurtemburg State, pass.. | Von Borries. | Kessler..... | 1889 | 4' 8½" | 6 | 4 | 17·11 | 1,132 | 170 | 16·54 | 23·62 | 1:2.04 | 22·05 | 64·96 | 61,712 | 90,400 | 3,408 | 4·36 | 3·63 |
| 26 | North Eastern, Eng., exp. | Worsdell.... | Co.'s Shops | 1888 | 4' 8½" | 8 | 4 | 17·33 | 1,195 | 160 | 18·00 | 26·00 | 1:2·12 | 24·00 | 84·00 | 71,630 | .... | 3,330 | 3·88 | 3·47 |
| 27 | " " " " | " ... | " " | 1889 | 4' 8½" | 8 | 2 | 19·91 | 1,140 | 176 | 20·00 | 28·00 | 1:1·96 | 24·00 | 91·34 | 39,670 | 104,470 | 4,214 | 7·38 | 5·95 |
| 28 | Great Eastern, Eng., frt... | " ... | " " | 1890 | 4' 8½" | 6 | 6 | 17·87 | 1,214 | 176 | 18·09 | 26·00 | 1:2·09 | 24·00 | 57·88 | 88,160 | 88,160 | 5,350 | 4·53 | 3·65 |
| 29 | Jura-Simplon, Mogul..... | Winterthur. | Winterthur. | 1889 | 4' 8½" | 6 | 6 | 16·15 | 1,305 | 156 | 17·72 | 25·20 | 1:2·01 | 25·40 | 59·84 | 79,350 | 96,600 | 4,767 | 4·86 | 4·42 |
| 30 | Griasi-Tsaritsin,* pass.... | Urquhart... | Co.'s Shops. | 1887 | 5' 0" | 6 | 4 | .... | .... | 128 | 17·25 | 25·28 | 1:2·15 | 24·00 | 65·00 | 52,900 | .... | 3,334 | 6·54 | 7·07 |
| 31 | " " *freight . | " ... | " " | 1888 | 5' 0" | 6 | 6 | 17·00 | 1,189 | 128 | 18·50 | 25·60 | 1:1·91 | 24·00 | 51·20 | 79,350 | 79·350 | 4,662 | 5·50 | 6·11 |
| 32 | Vladicancus, freight.. ... | Lindner..... | Kolomna... | 1889 | 5' 0" | 8 | 8 | 19·91 | 1,916 | 156 | 19·69 | 27·95 | 1:2·01 | 25·40 | 47·24 | 109,100 | 109,100 | 7,439 | 5·51 | 5·01 |
| 33 | Michigan Central, pass.... | Pitkin.... | Schenect'dy | 1889 | 4' 9" | 10 | 6 | 22·71 | 1,679 | 180 | 20·00 | 29·00 | 1:2·10 | 24·00 | 68·00 | 96,075 | 126,500 | 5·785 | 4·37 | 3·43 |
| | **Three Cylinder Type.** | | | | | | | | | | | | | | | | | | | |
| 34 | L'n'n & N.W., Experiment | Webb....... | Co.'s Shops. | 1881 | 4' 8½" | 6 | 4 | 17·11 | 1,084 | 163 | 2 13·00 | 26·00 | 1:2·00 | 24·00 | 78·00 | 61,700 | 83,300 | 3,857 | 4·77 | 4·15 |
| 35 | " " Dreadnought | " .... | " " | 1886 | 4' 8½" | 6 | 4 | 19·91 | 1,362 | 180 | 14·00 | 30·00 | 1:2·29 | 24·00 | 75·00 | 66,120 | 97,000 | 5,070 | 6·19 | 4·95 |
| 36 | Western, express...... ... | " ...... | Sh'rp-St'w't | 1883 | 4' 8½" | 6 | 4 | 16·90 | 1,060 | 150 | 2 13·00 | 26·00 | 1:2·00 | 24·00 | 79·13 | 57,300 | 81,550 | 3,453 | 5·06 | 4·82 |
| 37 | French Northern.......... | Sauvage.... | Co.'s Shops. | 1888 | 4' 8½" | 8 | 6 | 22·61 | 1,224 | 200 | 17·00 | 27·56 | 1:2·68 | 27·56 | 64·00 | 89,500 | 104,500 | 5,552 | 5·22 | 3·73 |
| | **Four Cylinder Type.** | | | | | | | | | | | | | | | | | | | |
| 38 | French Northern, express. | De Glehn... | Soc. Als'c'ne | 1886 | 4' 8½" | 6 | 4 | 24·43 | 1,112 | 156 | 13·00 | 18·11 | 1:1·95 | 24·00 | 82·68 | 60,830 | 83,300 | 3,474 | 4·44 | 4·04 |
| 39 | Decauville, articulated.. | Mallet.. ... | Decauville. | 1887 | 2' 0" | 4 | 4 | 5·27 | 240 | 170 | 6·69 | 10·04 | 1·2·25 | 10·24 | 23·12 | 23,140 | 23,140 | 1,502 | 5·37 | 4·47 |
| 40 | " " ... | " ..... | " | 1888 | 2' 0" | 4 | 4 | 5·27 | 240 | 170 | 7·36 | 11.02 | 1:2·25 | 10·24 | 23·62 | 23,800 | 23,800 | 1,817 | 6·29 | 5·24 |
| 41 | Local lines, " ... | " .... | Soc. Als'c'ne | 1888 | 1m't'r | 4 | 4 | 8·18 | 452 | 170 | 9·84 | 14·96 | 1:2·31 | 18·11 | 35·43 | 49,600 | 49,600 | 3,832 | 6·56 | 5·47 |
| 42 | Durango-Zamarraqua..... | " ... | Couillet..... | 1889 | 1 " | 4 | 4 | 8·39 | 452 | 170 | 11·02 | 15·75 | 1:2·04 | 15·75 | 35·43 | 50,700 | 50,700 | 4,177 | 6·17 | 5·14 |
| 43 | Herault ................... | " ... | Cail ....... | 1890 | 4' 8½" | 4 | 4 | 16·15 | 823 | 170 | 12·00 | 18·11 | 1:2·27 | 20·47 | 47·24 | 68,300 | 68.300 | 4,836 | 5·91 | 4·92 |
| 44 | Central Swiss........ .... | " ..... | Maffei...... | 1890 | 4' 8½" | 4 | 4 | 19·38 | 1,346 | 170 | 13·00 | 21·65 | 1:2·40 | 25·19 | 55·12 | 112,400 | 112 400 | 6,912 | 5·40 | 4·50 |
| 45 | Gothard............. .... | " ..... | " ... | 1889 | 4' 8½" | 6 | 6 | 23·68 | 1,658 | 170 | 15·75 | 22·83 | 1:2·10 | 25·19 | 48·43 | 169,800 | 169,800 | 9,990 | 4·54 | 3·80 |
| 46 | French Northern.......... | Du B'squet. | Co.'s Shops. | 1888 | 4' 8½" | 4 | 4 | 22·39 | 1,356 | 142 | 15·00 | 26·00 | 1:3·00 | 25·59 | 51·18 | 113 950 | 113,950 | 7,220 | 8·42 | 8·40 |
| 47 | Paris-Lyons-Med. pass.... | P.-L.-M... | " " | 1889 | 4' 8½" | 8 | 4 | 25·19 | 1,340 | 213 | 12·20 | 19·69 | 1:2·61 | 24·40 | 78·74 | 65.250 | 117,900 | 4,469 | 5·23 | 3·48 |
| 48 | " " " frt..... | " " " .... | " " | 1889 | 4' 8½" | 8 | 8 | 26·51 | 1,668 | 213 | 13·39 | 21·26 | 1:2·52 | 25·59 | 59·50 | 125,400 | 125,400 | 7,513 | 4·44 | 2·96 |
| 49 | " " "h'vy gr'd's | " " " .... | " " | 1889 | 4' 8½" | 8 | 8 | 23·47 | 1,647 | 213 | 14·17 | 21·26 | 1:2·25 | 25·59 | 49·61 | 125,700 | 125,700 | 10,030 | 5·28 | 3·52 |
| 50 | Baltimore & Ohio, pass... | Baldwin.... | Baldwin ... | 1889 | 4' 8½" | 8 | 4 | 25·08 | 1,604 | 163 | 12·00 | 20·00 | 1:2·77 | 24·00 | 66·00 | 75,400 | 105.350 | 3.883 | 5·49 | 4·78 |

Note.—Engines marked * were rebuilt from simple engines. The formula used for calculating "tractive effort" is $0·50p\frac{d^2l}{D}$.

The formula used for calculating proportional volume of expansion is $\frac{d'^2l}{DP}$. For computing proportional volume of expansion reduced to uniform pressure (142 lbs.) it is $\frac{d'^2l}{DPp}$.

a new compound system, claiming that his machine is always worked on the compound system, while mine could be worked either as compound engines or by steam taken directly from the boiler. Really there is no difference in principle; it is simply a question of convenience; because my locomotives can work as ordinary engines it does not follow that they must do so when it is not necessary. In fact, the direct admission of steam is only used under extraordinary circumstances. The economy again is not on account of the system of admission of steam, but the application of the compound principle. American engineers, disinterested as to the origin of the compound engine, have judged more fairly than those in Europe.

It has, however, been remarked with some malice that while the double-expansion locomotive with two cylinders originated in France, it is least employed there, and it would be difficult to give the reasons for this fact.

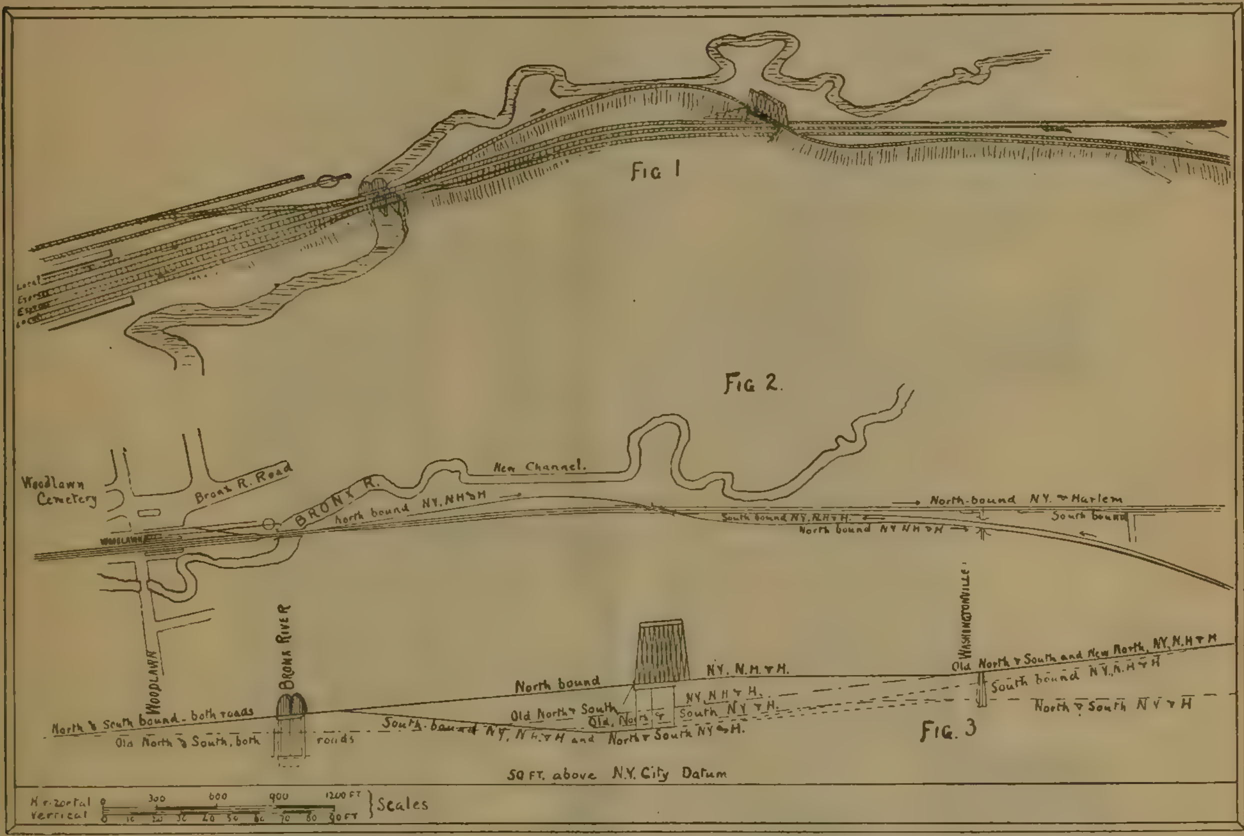
To go forward a little further, something has been done in many quarters with the compound locomotive either by construction of new engines or by the alterations of existing ones. In 1886 Mr. Thomas Urquhart, Chief Engineer of the Griazi-Tsaritsin Railroad in Russia, altered a six-wheel coupled freight engine to a two-cylinder compound to study the real value of the system. The results have been so favorable that Mr. Urquhart has already 21 of his engines changed to compound. All these engines, by the way, burn petroleum.

On the Holland State Railroads, some old engines were changed and some new compound locomotives were built at about the same time. On a few of these the singular arrangement was adopted of having two cylinders of unequal volume, but of the same diameter, the difference being made in the stroke. Thus both cylinders were 17.9 in. in diameter; the stroke of one was 15.75 in., and of the other 31.50 in., which gave a ratio of 1:2 between the cubic contents. This arrangement was not continued, and the only reason given in its favor was the fear of having unequal strains upon two pistons of differing diameter, when steam was admitted directly, which was done by a throttle valve similar to those used on the Bayonne-Biarritz engines. Some very interesting experiments were made with these machines.

It is useless to go further in this enumeration. It is sufficient to say that of the 900 compound locomotives now in use from 700 to 750—that is, 80 per cent.—are of the two-cylinder type, of which we are speaking.

As I have said above, the engines of this type differ only from those built for the Bayonne-Biarritz by some small modifications in the arrangement of the minor parts. These are the starting apparatus and that for changing direction, and it will be well to review here briefly the more important of the forms adopted for these parts.

(TO BE CONTINUED.)



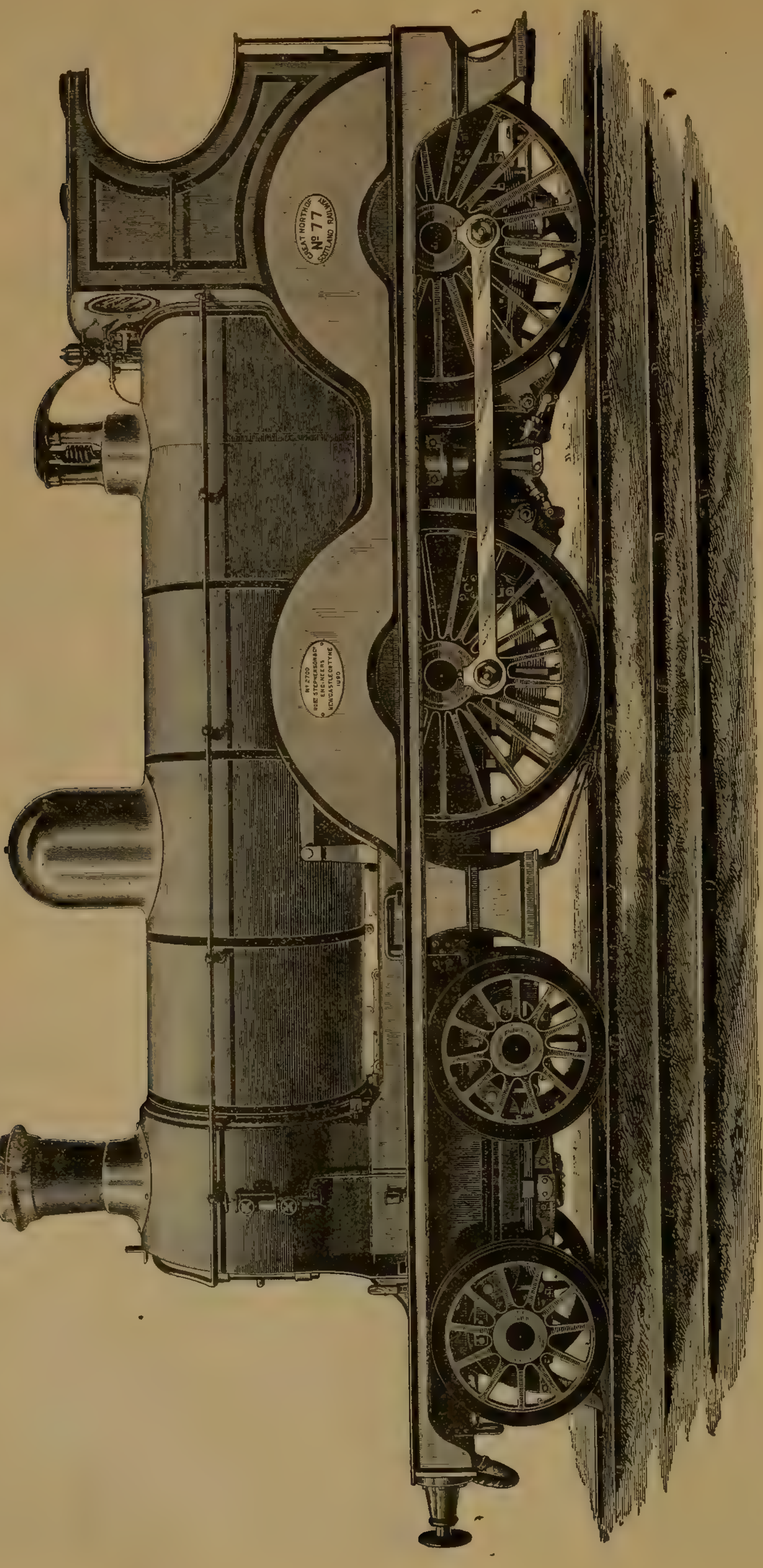

ARRANGEMENT OF TRACKS AT WOODLAWN JUNCTION.

## A JUNCTION PROBLEM.

THE accompanying illustration shows the plan adopted in disposing of a somewhat difficult problem presented at Woodlawn, the junction of the New York, New Haven & Hartford with the New York & Harlem tracks, a few miles from New York City. Fig. 1 is a perspective view; fig. 2 a plan; fig. 3 a profile of the new arrangement of tracks and grades at this point, which has been designed by Chief Engineer Katté.

At Woodlawn station, just below the crossing of the Bronx River, the four-track line of the New York & Harlem Railroad terminates, the road above that point having a double track only, and just above the crossing of the river the tracks of the New Haven road come in. Some time ago, in order to avoid the crossover outside of the Grand Central Depot in New York, the plan of running the Harlem trains on the left-hand track was adopted, but the New Haven trains, on their own road, continued to run upon the right-hand track according to the general custom. This involved an additional crossover at the junction, which, of course, always presents elements of delay and danger, and it is to avoid this additional grade crossing that the new arrangement has been adopted.

The diagram is so plain that very little explanation will be required. It will be seen that the north-bound New Haven track under the new arrangement will leave the north-bound Harlem track at a point close to the Bronx River Bridge, and will be carried on a gradually ascending




EXPRESS PASSENGER LOCOMOTIVE, GREAT NORTH OF SCOTLAND RAILWAY.

BUILT BY ROBERT STEPHENSON & COMPANY, NEWCASTLE-ON-TYNE, ENGLAND.

grade for about 1,600 ft., when it will cross the Harlem tracks and the south-bound track of its own road on a bridge, and will continue on a level and then on a slightly ascending grade until it again meets the south-bound track. The grade of the Harlem tracks will be slightly raised from Woodlawn station to a point beyond the crossing of the Bronx, where it will change to a descending grade for about 1,500 ft., and then to a gradually rising grade until it meets the old level at Washingtonville. The south-bound New Haven track will leave the Harlem grade just beyond the point where the north-bound track crosses it, and will have a continuous ascent, slightly greater than that of the old line, until it is rejoined by the north-bound track. The work involved in this change is not of a very expensive nature. It includes the raising of the north-bound New Haven track on an embankment; raising the Bronx River Bridge; the bridge over the Harlem tracks; some embankment required for the change of the Harlem grades, and the excavation of a new channel for the Bronx River for a distance of about 1,000 ft. The gain in convenience and safety of running will much more than compensate for the additional expense.

With the completion of the work of sinking the tracks through the Annexed District of New York City, the Harlem Division of the New York Central has a four-track line from the Grand Central Depot to Woodlawn, with the exception of the short break at Harlem Bridge. The two outside tracks are used for running the local trains and the two inner tracks for express trains. In that distance also the road is now free from grade crossings of streets, being permanently below the city level. The only question which remains to be settled is the much-discussed problem of the Harlem River crossing.

## AN ENGLISH EXPRESS LOCOMOTIVE.

THE accompanying illustration shows one of several express passenger locomotives recently built by the firm of Robert Stephenson & Company, Newcastle-upon-Tyne, England, for the Great North of Scotland Railway, from the designs of Mr. Robert Manson, Locomotive Superintendent of the road. For the engraving and description we are indebted to the London *Engineer*.

The engine is of the eight-wheel type, having two pairs of driving-wheels 6 ft. 6½ in. in diameter, and a four-wheeled truck in front, the truck wheels being 3 ft. 9½ in. in diameter. The engines have inside cylinders 18 in. in diameter and 26 in. stroke, the cylinders being cast together in one piece, the slide-valves being placed on the top of the cylinders, and driven by a link motion and rocking levers. The engines are fitted with balanced slide-valves, designed by Mr. Manson. The pressure on the back of the valve is relieved by a ring, which is held up to the casing door by a light tripod spring. This arrangement greatly reduces the wear and tear of the valves and gear, and since it was adopted by Mr. Manson on the Great North of Scotland Railway, engines have run 100,000 train miles, with a wear of the slide-valves amounting to only $\frac{3}{16}$ in.

The truck is provided with the ordinary swinging arrangement, which enables the engine to pass round curves with perfect steadiness. The main frames, which are of steel, are set in at the front end to give sufficient clearance for the truck wheels. The wheels are of wrought iron, and the coupled wheels have the balance weights forged solid.

The boiler barrel and fire-box casing are of best Yorkshire iron, the internal fire-box and tubes being of copper. There are 1087 sq. ft. of heating surface in the tubes, and 106 sq. ft. in the fire-box, giving a total heating surface of 1193 sq. ft. The grate surface is 18 sq. ft.; the fire-box is fitted with 16 copper air tubes, 3 in. external diameter, No. 7 w. g. thick, in two rows of eight in front and back, for conducting streams of air into the fire-box. This arrangement has been successfully used on the Great North of Scotland Railway for upward of 30 years, being originally employed as Mr. D. K. Clark's system of steam-induced air currents. In practice it has been found that the steam nozzles are not required when the engine is running, and the blower in the chimney answers when the steam is shut off. The boiler is fed by two No. 8 Gresham & Craven self-acting re-starting injectors, the water being delivered near the center of the barrel by a pipe inside the boiler, the clack-boxes being fixed on the back of the fire-box. Sand is delivered in front of the driving-wheels by Gresham's steam-sanding apparatus.

The engines are fitted with the Westinghouse brake, the main and auxiliary reservoirs for which form part of the drag-plate casting. The engines are also fitted with Mr. Manson's train tablet exchanging apparatus.

The weight of this engine light is 86,900 lbs.; in working order it is 94,100 lbs., of which 61,800 lbs. are carried on the drivers and 32,300 lbs. on the truck.

The tender is carried on eight wheels, the four hind wheels being connected to the main frame of the tender, while the four front wheels are connected to a truck of the same design and construction as the engine truck. The tank carries 3,000 gallons of water and about three tons of coal. The weight of the tender when loaded with coal and water is 80,600 lbs.

## THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.



(*Continued from page* 33.)

### VI.—CONTROLLABLE MINES.

AN efficient system of controllable submarine mines was an impossibility until the progress in electrical science placed within the hands of the engineer a reliable agent through which this control could with certainty be exercised. A mechanical controllable mine is a possibility, as was shown in the early days of the Rebellion, to which reference has already been made; but to operate this kind of a mine requires such a concurrence of favorable conditions that, together with the unreliability of the agents which must be employed, it places it altogether out of the question in considering a system of mine defense. A controllable mine is, therefore, an electrical mine, although the converse of this is not always true, since some of the strictly self-acting mines are exploded by electrical agency, as has been previously described.

The same division into *Ground* and *Buoyant* Mines exists among controllable as in those that are automatic, although, from the conditions, a buoyant mine much better fulfills the requirements of a contact mine than one that is placed upon the bottom of a channel, and which must be exploded by means of a dummy or buoy attached.

*Controllable Mines* are classed under two different heads, dependent upon the method adopted for firing them, into *Observation* or *Judgment* and *Electro-Contact* Mines. An observation mine is usually a ground mine whose position is known by means of cross-bearings of objects on shore, by plane tables or other instruments, which will indicate just where the mine is and also when a vessel is above it.

This method of firing possesses the advantage of simplicity, since no circuit-closing arrangement is necessary—the battery, the fuse within the mine, and the key of the operator completing the electrical circuit. It was one of the first methods adopted for electrical mines. It is, however, open to the objections that a clear field of vision is required to locate both the mine itself and its object. Darkness, a thick fog, or the smoke of battle would render such a system for the time inoperative, except that a properly placed search light might obviate, in a measure, this difficulty. Furthermore, the greatest care must be exercised in putting down an observation mine so that its position cannot be mistaken; and finally the whole efficiency of the mine rests upon the man at the firing-key, who may err in judgment not only as to the relative posi-

tions of mine and ship, but also be at fault when called upon to decide upon the instant whether an approaching vessel be that of friend or foe—a contingency likely to happen in any harbor attack where fleets are engaged, and to face which would require a combination of coolness, nerve and quick judgment few men would care to be called upon to exercise.

An electro-contact mine, on the other hand, leaves nothing to the judgment of the observer as to the position

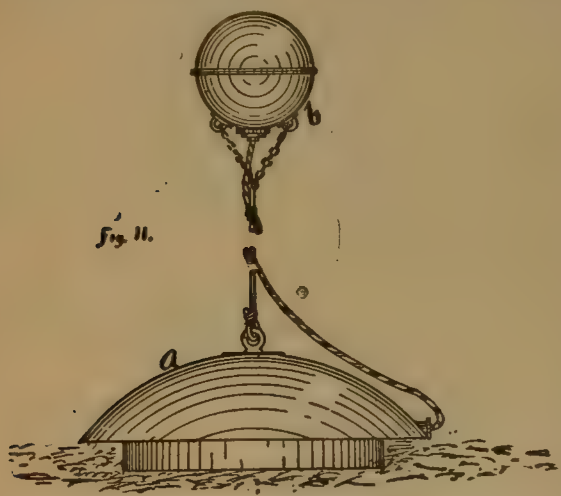


Fig. 11.

of an enemy's ship. He may mistake a friendly for a hostile craft, but he will never mistake its position, since the blow from a passing vessel will at once indicate to the shore station that it is above the mine. Such mines may be arranged so as to be fired at will or automatically. In the one case the blow closes an electrical circuit and signals the fact to the observer by dropping a shutter or ringing a bell, leaving it to his will whether or not to explode the mine; or the signaling current may, instead, be made to switch in a powerful firing battery, and thus explode the mine in a purely automatic manner. The advantages of such a system of mines in a channel or

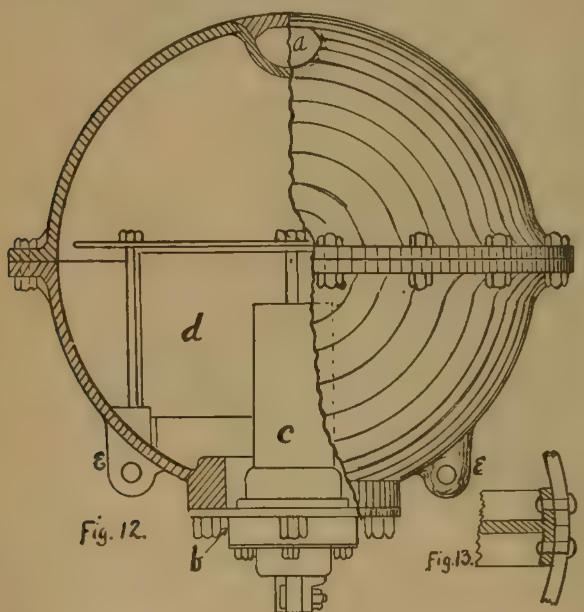


Fig. 12.

Fig. 13.

water way, that must be used by friendly ships and may be used by a hostile fleet, are too obvious to need mentioning.

An observation ground mine may be converted into a contact mine by the employment of a buoy anchored above it, which carries the circuit-closing apparatus, and with which it is in electrical connection. Fig. 11 shows such an arrangement, the buoy *b*, carrying the signaling or circuit-closing device, the mine *a*, containing the fuse and the explosive.

A controllable buoyant mine carries within its case a circuit-closer, an electrical fuse and the explosive charge. Fig. 12 shows, partly in section, the English spherical mine case—Gibbins'—previously referred to. It may be of iron or steel, in two hemispheres, and bolted together as shown. The upper hemisphere is provided with a sunken eye-bolt *a* for purposes of handling. The lower hemisphere has the loading-hole, *b*, into which is inserted and bolted a cylindrical case, *c*, containing the circuit-closer, the fuse and the priming charge. Secured within this lower hemisphere is an iron case, *d*, containing the main charge of explosive, in the center of which is the case containing the fuse and priming charge; *e e* are lugs for mooring purposes.

Another method of joining the two hemispheres so as to eliminate the objection to the protruding flanges of the other form—in the hold they would give to the grappling irons of an enemy—is shown in fig. 13. Here an inside web plate of T iron is provided, to which is riveted the edges of the two hemispheres.

Fig. 14 shows the form of the McEvoy ground mine. The case is of cast iron, the base of which is of sufficient thickness to give the necessary mooring weight. The dome-shaped portion varies from about ½ to 1 in. in thickness, according to the depth of water in which it will be located. The case for the 500-lb. mine weighs 800, that for the 1,000-lb. mine, 2,000 lbs. In this figure *a* is the loading-hole; *b* the fuse and primer case; *c* the connecting cable, and *d d* lugs for handling or attaching a buoy.

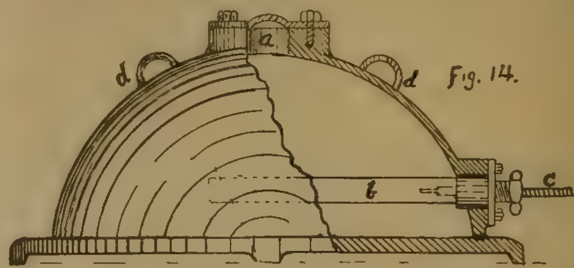


Fig. 14.

In the United States service the case for the buoyant mine is spherical in form and made of two thin hemispheres of steel, the narrow flanges of which are welded together, forming a water-tight joint. The hemispheres are pressed into shape by hydraulic machinery. The case for the 100-lbs. mine is 32 in. in diameter and ¼ of an inch in thickness. For ground mines the mushroom shape, as shown in fig. 11, is recommended. The material is cast iron; the size and thickness of case depending, of course, upon the amount of explosive it is to contain and the depth of water in which submerged; the buoy in this figure representing our spherical mine case.

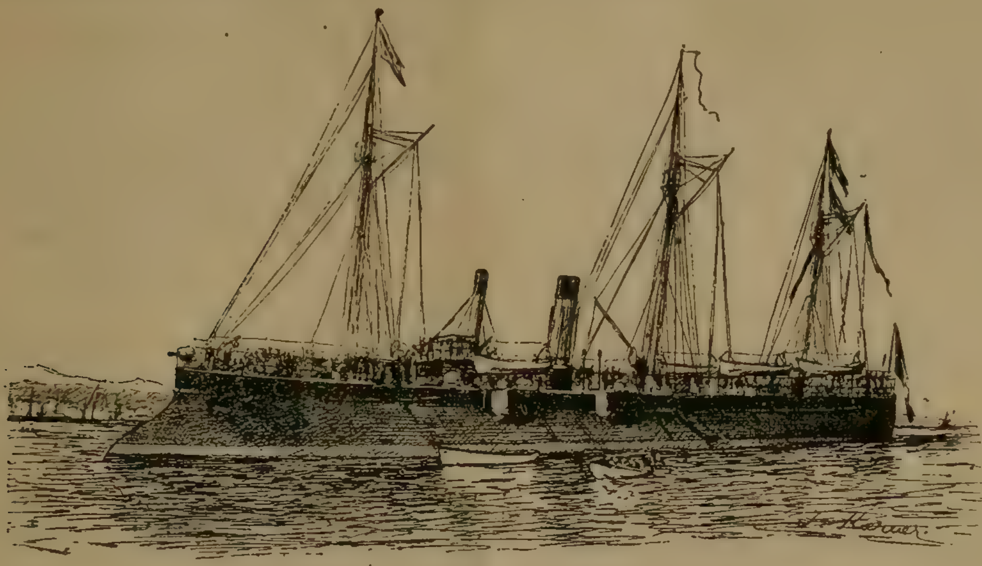
All mine cases are tested for two qualities—that of being water-tight and having sufficient strength to resist external pressure. For the first, they are filled with water which is subjected to moderate pressure, and for the second are submerged in water of greater depth than where they are to be moored, and left for at least 48 hours.

### VII.—CIRCUIT-CLOSERS.

In any system of electrical mines the most vulnerable part is the operating apparatus. It is that part most liable to get out of order and at the same time that upon which the whole efficiency of the system depends. No matter how powerful your mines may be nor how effectively placed if, when brought to the test of actual service, the smallest link in a rather intricate chain fails to perfectly perform its function, the failure of the whole system is sure to follow. The links in this chain, upon which so much depends, are the signaling and firing batteries, the connecting cables, the fuses and the circuit-closers. While all are equally important to the perfect working of the system, the circuit-closer is the more intricate in its construction, and more liable, consequently, to cause failure in the operation of a system of mines.

A circuit-closer, as used in submarine mining, is a contrivance for bridging a gap in an electrical circuit, which

while a third is being built in the Navy Yard at Yokoska, in Japan. It has also building in France two torpedo cruisers of 700 tons displacement. This is in addition to two cruisers recently built in England.



NEW CRUISER "SURCOUF," FOR THE FRENCH NAVY.

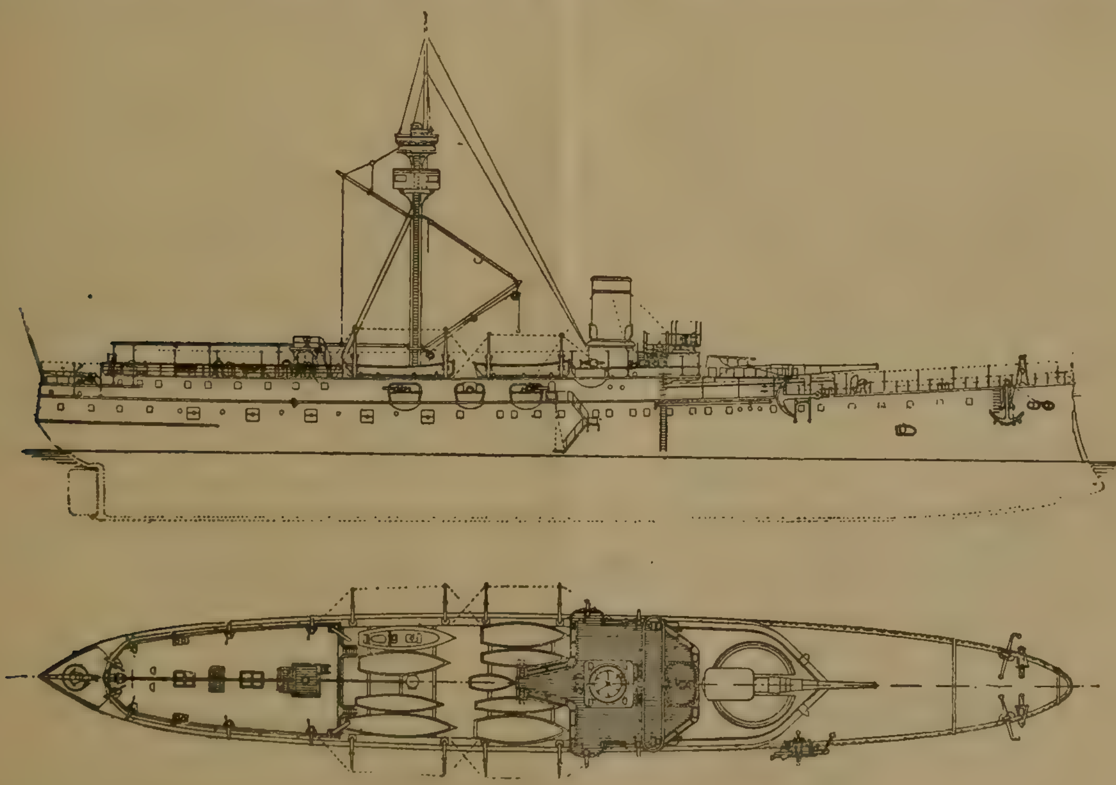
A FRENCH FAST CRUISER.

The accompanying illustration, from *Le Yacht*, shows the French third-class cruiser *Surcouf*, which recently had her speed trials. The *Surcouf* is 95 meters (311.75 ft.) long; 9.30 m. (30.5 ft.) greatest breadth; 6.54 m. (21.5 ft.) depth, and has a mean draft of 4.24 m. (13.9 ft.).

The two engines are of the horizontal compound type, having cylinders 0.935 m. (36.71 in.) and 1.879 m. (74.18 in.) in diameter, by 0.915 m. (36 in.) stroke. Working at full power they make 135 revolutions, giving a piston speed of 4.12 m. (13.51 ft.) per second. Each cylinder has two piston-valves worked by Marshall gear. The reversing, etc., is done by a small steam-engine.

There are six boilers each 2.92 m. (9.58 ft.) in diameter and 5.80 m. (19 ft.) long. Each boiler has two fire-boxes and a grate surface of 48.44 sq. ft. The heating surface is 2,349 sq. ft. The usual working pressure is 192 lbs. In the preliminary trials these boilers vaporized 8.8 lbs. of water per pound of coal burned.

On a six-hour trial with natural draft the engines developed 3,508 H.P., giving the ship a speed of 17.3 knots. With 1,800 H.P. developed, the fires being kept low, a speed of 15 knots was reached. With forced draft, on a two-hour trial, a speed of 20.51 knots was reached, the engines making 133 revolutions, and developing 6,287 H.P. The contract under which these engines were built called for 6,000 H.P. with forced draft, so that the requirements were exceeded.



JAPANESE COAST DEFENSE SHIP "ITSUKUSHIMA."

NEW SHIPS FOR THE BRITISH NAVY.

During the present month the keels of two vessels, the construction of which was provided for in the last Naval Defense Bill, have been laid in Her Majesty's Dockyards. The *Crescent*, a steel cruiser of the protective deck type, has been commenced in the No. 11 dock at Portsmouth, and a quantity of material for the *Barfleur*, a second-class battle-ship of the barbette type, has been placed in position on the blocks in the No. 7 slipway at Chatham. The former vessel belongs to a type which is considered to be an improvement on the *Phæton* class, and will be 360 ft. in length by 60.7 ft. in extreme breadth, with a displacement of 7,700 tons on a draft of water of 24 7 ft. Her normal coal supply is fixed at 850 tons, and she will be fitted with engines capable of developing upward of 12,000 H.P., with which it is expected a speed of 19 5 knots will be realized. The main armament will consist of two 9.25 in. 22-ton breech-loading guns and ten 6-in. guns, while the auxiliary armament will be made up of sixteen 6-pdr. and 3-pdr. quick-firing guns, and four torpedo tubes. The *Barfleur* will in many respects resemble the larger class of battle-ship now in process of construction at the various Government and private establishments, of which the *Royal Sovereign* and *Hood*, building at Portsmouth and Chatham respectively, are types. Although inferior in armament, the *Barfleur* will rival her larger sisters both in coal supply and speed. She will measure 360 ft. 6 in. between perpendiculars, and 70 ft. in extreme breadth, with a displacement of 10,500 tons. Her engines, which are of the triple-expansion type, will develop 12,000 H.P., from which a speed of 18 knots is anticipated. She will carry in barbettes four 10-in., 29 ton breech-loading guns, and will mount, in addition, ten 36-pdr. and 17 quick-firing guns, besides six torpedo-tubes for the discharge of Whitehead torpedoes. A sister vessel, to be named the *Centurion*, will be commenced at Portsmouth in a few days.—*Industries.*

RUSSIAN ARMOR TRIALS.

On November 11, under direction of officers of the Russian Navy, tests were made at Ochta of three armor-plates, which had been procured for the purpose of a comparative trial. One of these was a compound plate, from Brown, of Sheffield, England; one a steel plate from Vickers, of Sheffield, and the third a nickel-steel plate from Schneider, of Creusot, France. All were of the same thickness. Each received five blows, the projectiles used being 5.9-in. Holtzer chrome-steel shells, weighing 90 lbs. each; the first and second were fired with a velocity of 1,900 ft., the other three 2,100 ft.

In the compound plate the first two shells penetrated 13.4 in.; the other three passed through the plate and backing and fell some distance beyond. The plate was very badly cracked.

In the Vickers plate the greatest penetration was 20.9 in.; the plate showed only light cracks.

The Schneider plate stopped all five of the projectiles and broke three of them. The penetration of the two unbroken shells was 8.66 and 10.63 in. The plate was very slightly cracked and but little injured.

It will be seen that these experiments correspond very closely in their results with those secured in the Annapolis tests.

AN ITALIAN SUBMARINE BOAT.

An Italian engineer, Sr. Balsamello, has invented a submarine boat of a new type. The peculiarity of this boat is that it is spherical in form. The sphere contains the motive apparatus and that necessary to submerge the boat and return it to the surface. It is provided with glazed port-holes, or windows, and also with grapples worked from the inside, with which objects can be seized at will.

At a recent trial of this boat at Civita Vecchia, it worked very satisfactorily. It remained submerged for a long time without difficulty, and was readily turned and managed, both under water and on the surface. It passed under the keel of a battle-ship in the harbor without being seen. On a second trial of this kind, at an appointed time, a large raft was thrown overboard from the deck of the battle-ship; in a moment there was an explosion and the raft was blown to pieces, while at the same moment the submarine boat came to the surface about 130 ft. away.

The details of Sr. Balsamello's invention are for the present kept secret by the Italian Government. If the accounts of the test are correct, she must be a formidable craft.

Fig. 217.

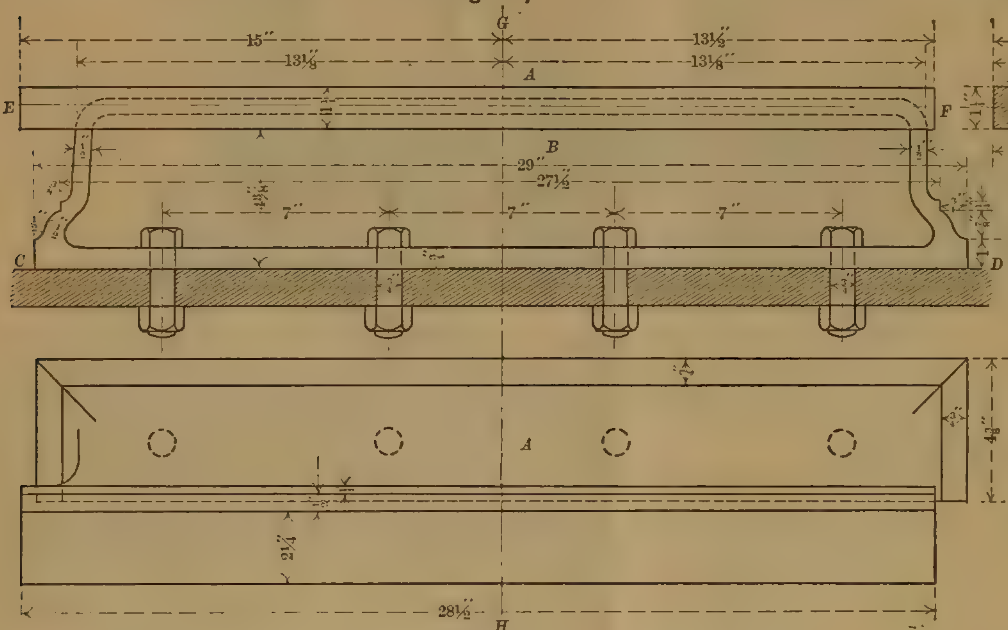


Fig. 218.

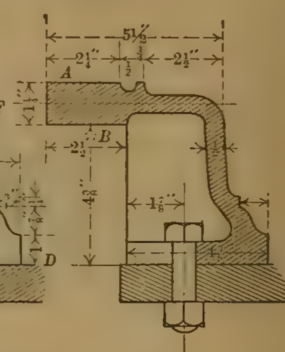


Fig. 219.

GUIDES FOR STATIONARY ENGINE. SCALE, 2 IN. = 1 FT.

## THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

(*Continued from page* 41.)

CHAPTER VII.—(*Continued.*)

### THE STEAM-ENGINE.

GUIDES.

In double-acting steam cylinders—that is, in those in which steam is admitted on both sides of the piston—it is essential that the piston-rod should be made so as to be capable of working steam tight where it passes through the cylinder head. To do this, it must always move in a straight line. By reference to Plate II, fig. *A*, it will be seen that when the crank is in any other position excepting the two dead-points, the connecting-rod is inclined to the longitudinal center line *A B*, passing through the piston-rod and cylinder. Consequently, the steam pressure which is transmitted to the crank by the connect-

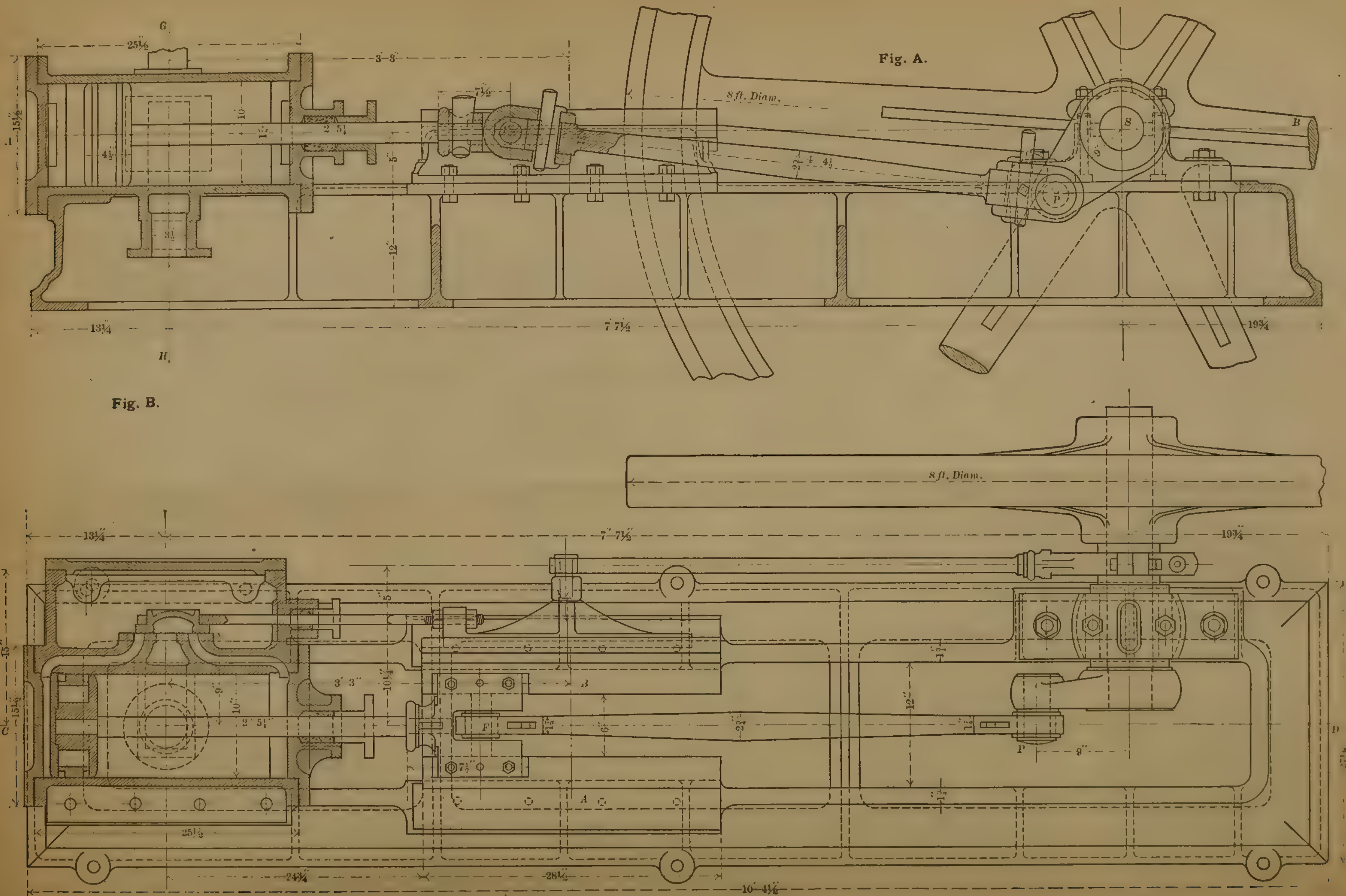



PLATE II. STATIONARY ENGINE, 10-INCH CYLINDER. SCALE, 1 IN. = 1 FT.
BUILT BY THE FISHKILL LANDING MACHINE WORKS, FISHKILL-ON-HUDSON, N. Y.

ing-rod causes the latter to exert an upward or a downward pressure on the end of the piston-rod, and if it was not supported in some way this pressure would "spring" the rod and cause it to diverge more or less from a straight line while it is moving. As has been explained, a sliding block, or cross-head, is attached to the end of the piston-rod, to cause the latter to move in a straight line. The cross-head has bearings which slide on bars, called *guide-bars*, fastened to the engine frame or cylinder, so as to be exactly parallel to the center line of the cylinder. The lateral pressure on the end of the piston-rod is transmitted to these bars by the bearings of the cross-head, which slide on the guide-bars, and the piston-rod must, therefore, move in a line coincident with the center line of the cylinder.

Figs. 217, 218 and 219 represent one of the guide bars of the engine which has been illustrated in this chapter. This is made of cast iron, although in some classes of engines they are often made of wrought iron or steel. Fig. 217 is a side view looking at the guide-bar from the inside of the engine; fig. 218 is a transverse section, and shows the form of the casting, and fig. 219 is a plan. The student should draw this half size. It is bolted to the engine frame by the four bolts which are shown. The slides work on the top $A$ and bottom $B$ of the bar, which is planed and filed so as to be perfectly straight. In drawing the guide-bar, a horizontal line, $C\ D$, should first be laid down, representing the top of the frame. The distance from the top of the frame to the center-line of the cylinder should be ascertained, and the line $E\ F$ drawn. From these two lines various dimensions may be laid off. A vertical center-line, $G\ H$, should also be drawn, as shown in the engraving, from which other dimensions can be measured. The method of doing this will be obvious from the engravings.

Fig. 220.

Fig. 222.

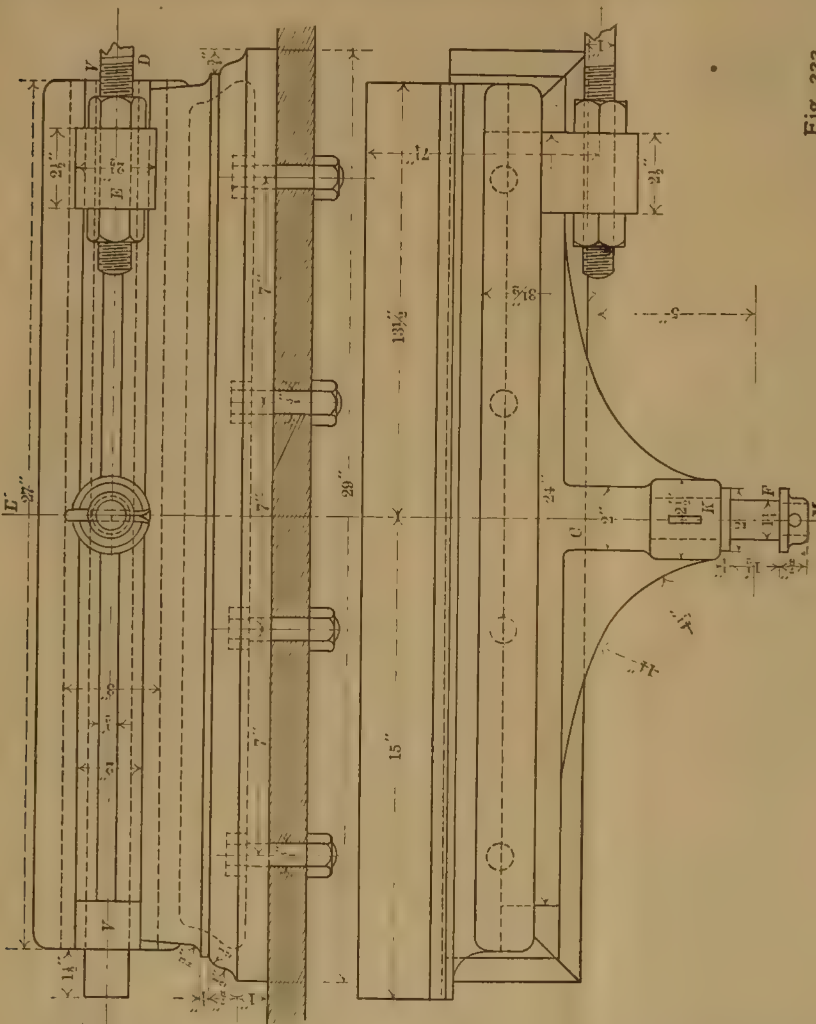
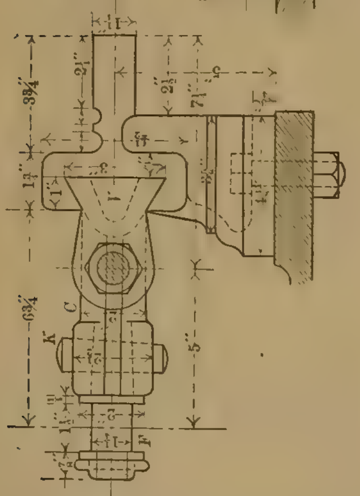


Fig. 221.



VALVE-STEM GUIDE FOR STATIONARY ENGINE. SCALE, 2 IN. = 1 FT.

VALVE-STEM GUIDE.

What has been said of the piston-rod is equally true of the valve-stem of an engine. It must also work steam tight through the end of the steam-chest, and the motion of the eccentric must be communicated to it by the eccentric-rod. Besides this, the center line of the eccentric, as shown in the plan fig. $B$, Plate II, is usually further from the center of the engine than the center of the valve-stem is. Consequently, their center lines are not "in line," or coincident with each other, and, therefore, the motion of the eccentric must be transmitted laterally. This makes some form of guide necessary for the valve-stem, as well as for the piston-rod. Such a guide is shown in figs. 220, 221 and 222, which represent the guide-bar $B$, fig. $B$, Plate II, which is opposite to $A$, the one illustrated by figs. 217–219. These two bars are similar to each other, excepting that the one has a guide, $C$, for the valve-stem and the other has not. This guide consists of a sliding piece $C$, which works in a V-shaped groove $V\ V'$ in the casting which forms the guide-bar. The valve stem $D$ is fastened by two nuts to a lug $E$ on the front end of the slide. The eccentric-rod is connected to the pin $F$, which fits into a tapered hole in the sliding pin and is held by a key $K$.

The guide-bar in figs. 220–222 is drawn in the same way as the one shown in figs. 217–219. The horizontal center line of the valve-stem slide coincides with that of the cylinder and piston-rod. A vertical center line $L\ M$ should be laid down which passes through the center of the eccentric-rod pin, as shown in figs. 220 and 222. In the plan, fig. 222, and the end view, fig. 221, the center lines of the eccentric-rod and the valve-stem should be laid down as indicated by the figures, and these two rods should be drawn on these lines.

The eccentric-rod has an eye on its front end by which it is connected to the pin $F$. This eye has a steel bushing, or ring, fitted into it which can be removed and replaced by a new one when it becomes worn. Sometimes a strap-end is used on the eccentric-rod instead of an eye.

GENERAL DRAWINGS OF A STEAM-ENGINE.

The student, having drawn the details of an engine, is now prepared to assemble the various parts and draw the complete engine. To show the construction of the various parts, it is advisable to show some of them in section. Thus, instead of representing a side view of the whole machine, it is best to draw a longitudinal section, as in fig. $A$, Plate II. In the plan, fig. $B$, Plate II, a section of the cylinder steam-chest and valve is shown, and a top view of the other parts. In both cases the sections are drawn on the center line of the cylinder.

The complete or *general drawings*, as they are called, shown in Plates II and III, should be drawn by the student to a scale of two or three inches to a foot. In making these drawings the first thing to do for figs. $A$ and $B$ is to lay down the longitudinal

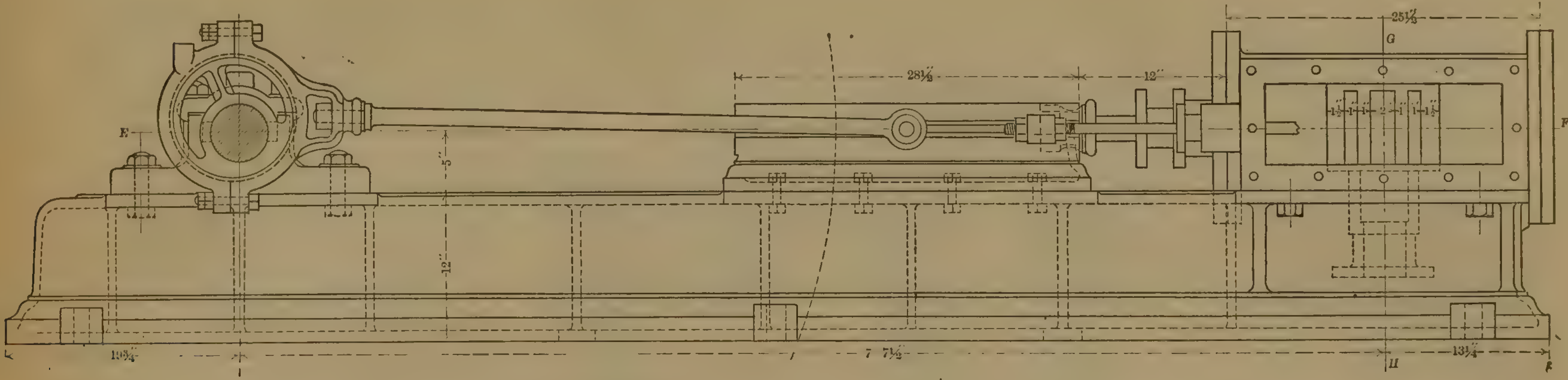



Fig. A.

Fig. D.

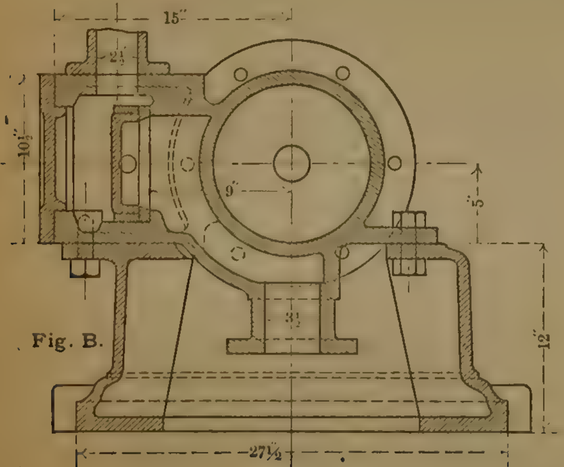



Fig. B.

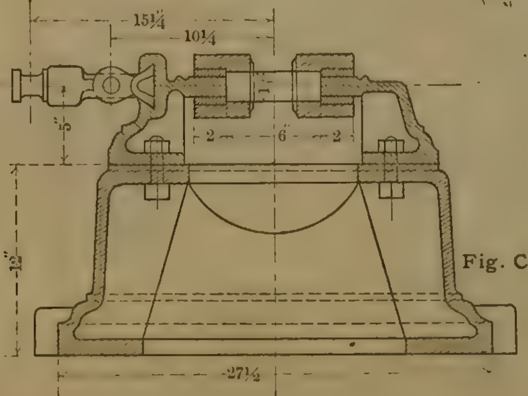



Fig. C.

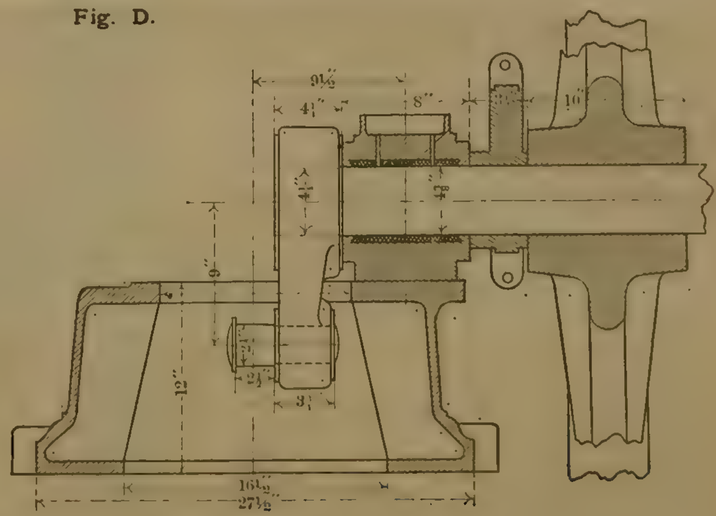



PLATE III. STATIONARY ENGINE, 10-INCH CYLINDER. SCALE, 1 IN. = 1 FT.

BUILT BY THE FISHKILL LANDING MACHINE WORKS, FISHKILL-ON-HUDSON, N. Y.

center lines $A$ $B$ and $C$ $D$ of the cylinder. $A$ $B$ will pass through the center of the shaft $S$, and $C$ $D$ passes through the middle of the crank-pin $P$. From fig. $A$ it will be seen that $A$ $B$ is 5 in. above the top of the frame, and fig. $A$, Plate I, shows that the frame is 12 in. deep. Two lines parallel to $A$ $B$, one of them 5 in. below it and the other 12 in. below the latter, should, therefore, be drawn. These will represent the top and bottom of the frame. A longitudinal section of the frame can then be drawn in fig. $A$, and a plan in fig. $B$ from the different views shown in Plate I. It should be noticed that the positions of the frame in Plates I and II are transposed or turned, "end for end," in relation to each other. The cause of this will be explained further on, but the learner must be careful in laying the frame out on his general drawing to get its position right in relation to its other parts. The vertical center lines which pass through the middle of the cylinder and the center of the shaft are shown in Plate I. These should be laid down on the drawings in their proper position in relation to the frame. The cylinder, piston, valve and steam-chest can then be drawn from figs. 207–216, for which no further explanation is required. The pedestal can also be drawn from figs. 198–200 on the lines which pass through the center of the shaft. After the pedestal is penciled in the crank may be drawn from figs. 186 and 187, in any position the student may fancy. The fly-wheel may also be represented on the shaft, the dimensions being taken from figs. 201 and 202.

In order to keep the engravings within the size to which they are limited, only a portion of the fly-wheel is shown, the rest being represented as though it was broken away. The student may take a sheet of paper sufficiently large and represent the whole wheel, which will add considerable to the pictorial effect of his drawing.

When the crank has been laid down, the length from the center of one journal to the center of the other of the connecting-rod should be laid off from the center of the crank-pin $P$, on the longitudinal center line of the cylinder at $F$. This point will be the center of the cross-head pin, which, with the cross-head, may be drawn from figs. 203 to 206, the position of the pin determining that of the other parts. In the plan fig. $B$, the crank is represented in the position it would occupy when the center of its pin is on the horizontal center-line $A$ $B$, or is at one of its *dead-points*, as they are called. It has been shown in this position in the plan to avoid having the crank and connecting-rod appear in inclined positions in this view, which adds materially to the difficulty of drawing them. After the crank is laid down in this position in fig. $B$, the center of the cross-head pin may be laid down at $F$ in the same way as has been explained—that is, by measuring a distance equal to the length of the connecting-rod from center to center, from the center of the crank-pin $P$ on the center line $C$ $D$ to $F$, which will be the center of the cross-head pin. The cross-head may then be drawn in the plan from fig. 204, noticing that its position must be reversed in fig. $B$ from that in which it is shown in fig. 204.

When the piston is in the middle of the cylinder the cross-head slides should be in the middle of the guides. From fig. 204 it will be seen that the center line of the cross-head pin passes through the middle of the slides. Consequently, if we ascertain the distance from the middle of the piston to the center of the cross-head pin, and lay that distance off from the middle line of the cylinder, on its horizontal center line, the point thus laid down will be the middle of the guides, which may then be drawn on this line from figs. 217–222. From fig. 215 it will be seen that the thickness of the piston is $4\frac{1}{2}$ in., and the length of its rod, measured from the back of the piston to the shoulder which bears against the cross-head boss, is 2 ft. $5\frac{1}{4}$ in.; and the distance from the front of the cross-head boss to the center of its pin is $7\frac{1}{2}$ in. Adding one-half the thickness of the piston $= 2\frac{1}{4}$ in. to the other dimensions, and we have $2\frac{1}{4}'' + 2'\ 5\frac{1}{4}'' + 7\frac{1}{2}'' = 3'\ 3'' =$ the distance from the middle of the cylinder to the middle of the guides. This distance should be laid off as described.

After the position of the cross-head has been laid down, a center line should be drawn in fig. $A$ through the center of its pin and that of the crank-pin, and the connecting-rod can then be drawn on this center line from figs. 193 to 196. It can be shown in a similar way in plan in fig. $B$.

After all these parts have been penciled in, the student should ink those first which are nearest to the eye, because these are shown in full lines. If he attempts to ink in all the parts simultaneously, he is apt to become confused and draw some of the lines full which ought to be dotted. Thus, when the connecting-rod, crank, pedestal, frame and fly-wheel are drawn in pencil in fig. 8, the connecting-rod, which is nearest to they eye, should be inked in first, then the crank, after that the pedestal and frame, and last the fly-wheel, because the proximity of these to the eye are in the order in which they have been named.

It is desirable, however, in representing a steam-engine to show the valve and mechanism for moving it. As in this case these are on the back of the cylinder, another, or a back view, fig. $A$, Plate III, of the engine must be shown. In order to show the eccentric clearly, the fly-wheel is omitted in this view, excepting that part of its circumference is shown by a dotted line. The steam-chest cover and the valve are also omitted, in order to show the steam ports clearly. The eccentric and rod are drawn from figs. 189–192, the cross-head and valve-stem guides from figs. 217–222.

It will be noticed that this view of the engine is turned end for end from that in which it was shown in Plate II. The reason for this will be readily understood if the student will look at both sides of any object, say a wheelbarrow, and he will find that if views of both sides are represented they must be reversed in relation to each other. It will be seen, too, that the frame, cylinder, etc., in the detail drawings, are shown in the same position as in Plate III.

Fig. $B$ is a transverse section through the cylinder drawn on the vertical center line $G$ $H$ of Plates II and III. Fig. $C$ is a transverse section through the guides, and fig. $D$ a similar section on the center line of the shaft. The student should have no difficulty in drawing these views from the detail drawings.

(TO BE CONTINUED.)

# Manufactures.

### General Notes.

A NEW electric lighting system for railway cars is to be placed on the market some time during the year 1891 by the Consolidated Car Heating Company. Each car will have an independent source of light which will be available even when the car is at rest for five hours, or perhaps longer. The tax upon the motive power will be slight and indirect, no steam being used. The designers are now endeavoring to so simplify and cheapen the apparatus that it shall be, both in first cost and in running expense, more economical than any lights now used in first-class cars. The system will include storage batteries and a dynamo on each car, driven from the car axle.

THE Rhode Island Locomotive Works, in Providence, are building six four-wheel switching engines with 16 × 24-in. cylinders for the Boston & Albany, and 10 eight-wheel engines, with 18 × 24-in. cylinders, for the New York, New Haven & Hartford. These works have just completed a compound locomotive with high-pressure cylinder 18 × 24 in., low-pressure 28 × 24 in., driving-wheels 78 in. in diameter, boiler 52 in. diameter of barrel, and fire-box 78 in. long. This engine is intended for fast passenger service on the Georgia Southern & Florida Railroad, but will be tried on some Eastern roads before going to its destination.

THE Pennsylvania Machine Company, a new organization, will hereafter represent in Philadelphia the H. B. Smith Machine Company, the Fitchburg Machine Company, and a number of other concerns in the general machine business. The new company has its offices at 29 North Seventh Street, and J. J. White is President.

THE iron work of the new elevated line of the Pennsylvania Railroad through Jersey City will all be painted with the silica-graphite paint made by the Joseph Dixon Crucible Company in Jersey City. This paint has been adopted after careful examination as the best for the purpose. It has been in use for some time, with very good results, on other structures, where it has received severe tests.

THE Missouri Pacific Railroad has recently put in service 12 handsome passenger cars built at the Pullman Works. They are equipped with the Scarritt-Forney car seat with the new adjustable foot-rest.

THE Rogers Locomotive Works, Paterson, N. J., are building 25 mogul and three decapod locomotives for the Chicago, Burlington & Quincy Railroad.

THE Madison Car Company is building extensive shops in Madison, Ill., a new town lately established at the east end of the Merchant's Bridge at St. Louis. The three main buildings will be 650 800 and 935 ft. in length, and the capacity will be 26 box cars per day. The Company has let very large contracts for iron and wood-working tools to the Niles Tool Works, Hamilton, O.; A. B. Bowman, St. Louis; the Blakeslee

Manufacturing Company, Cleveland, O; J. A. Fay & Company, Cincinnati; Greenlee & Company, Chicago, and the Berry & Orton Company, Philadelphia. The engines, boilers and similar work will be furnished by the Rankin & Fritsch Company and John O'Brien & Company, of St. Louis.

It is stated that the process for producing aluminum direct from the ore adopted by the Cowles Electric Smelting & Aluminum Company has been so improved that the metal 98 per cent. pure can be produced at a cost of $1.25 per lb. It is proposed to give up the production of iron and copper alloys at the Lockport Works, and to use the entire plant there in the manufacture of pure aluminum. The output will then be from 1,000 to 1,500 lbs. per day.

Three locomotives from the Baldwin Works were recently put in service on the Philadelphia Division of the Baltimore & Ohio Railroad. They are eight-wheel passenger engines, with cylinders 20 × 24 in., driving-wheels 78 in. and truck-wheels 36 in. in diameter.

The Great Western Construction Company has been organized to build works in Chicago for the manufacture of locomotives on a plan devised and patented by Hugh R. Walker, which relates chiefly to the arrangement of the fire-box. The incorporators are Hugh R. Walker, Alfred Skinner and Thomas A. Winham.

The Midgley Wire Belt Company, Beaver Falls, Pa., is making an increased amount of wire-belting; an order has been received from the Government for a sample of torpedo netting.

The plant of the Ryan & McDonald Company, manufacturers of contractors' tools, cars, etc., is being removed from Waterloo, N. Y., to South Baltimore, where a shop, 70 × 350 ft. in size, is nearly finished.

The Pullman Sash Balance Company, Rochester, N. Y., has presented a new device for windows which seems to work very well indeed. It is being introduced on a number of roads.

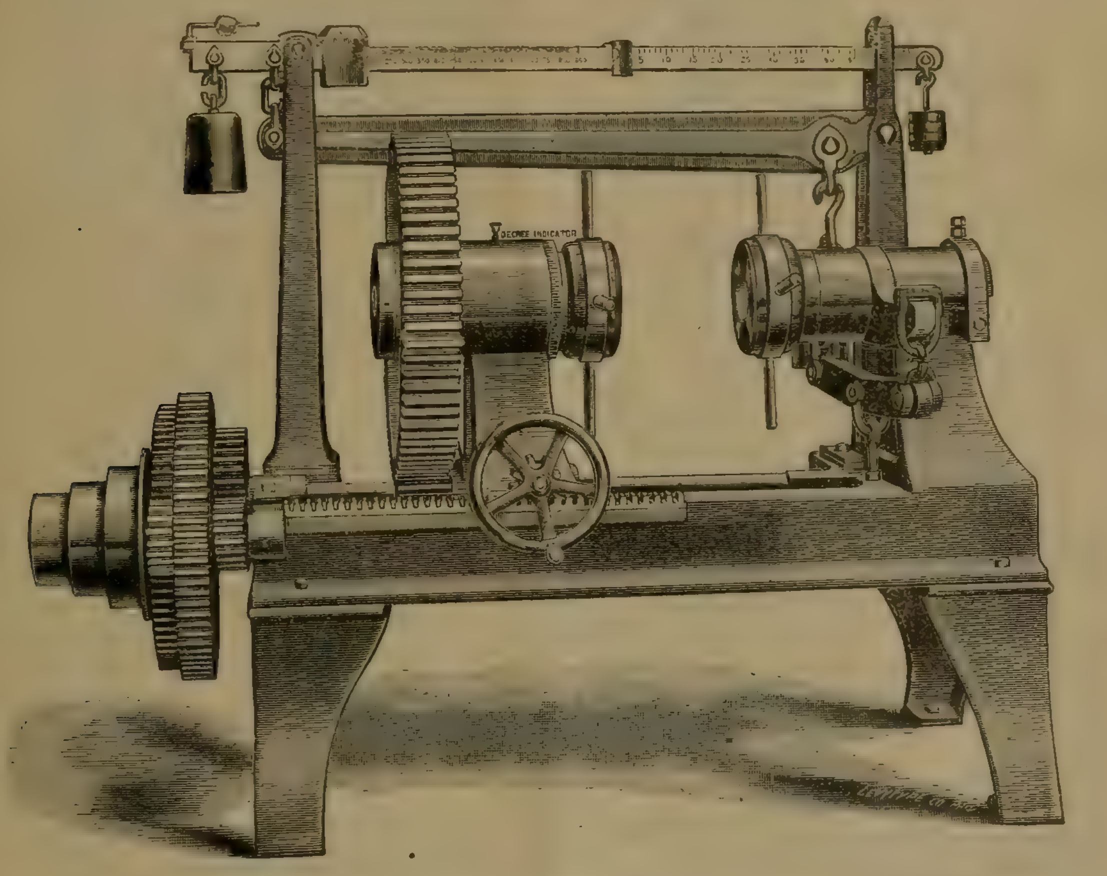
The engines for the Lighthouse tender *Marigold*, recently completed by the Detroit Dry Dock Company, Detroit, Mich., are of the direct-acting, vertical, triple-expansion type, with cylinders 14½, 22 and 36 in. in diameter, and 24 in. stroke. Steam is furnished by two steel boilers, 10 ft. 6 in. in diameter and 10 ft. 10 in. long. The boat is 159 ft. 6 in. long; 27 ft. beam; 12 ft. deep, and draws 9 ft. 10 in. of water.

The new "U. S. automatic block signal," which has been tried on several roads, is now controlled by the Martin Anti-Fire Car Heater Company, of Dunkirk, N. Y., and that company will shortly be prepared to put it on the market.

## An Improved Torsional Testing Machine.

The accompanying illustration shows a new torsional testing machine with iron frame, manufactured by the well-known firm of Riehle Brothers in Philadelphia. The general arrangement and construction is well shown in the cut.

The fixed head carrying self-centering grips has arms 1 ft. in length, projecting either side of the grip-head, which is supported on a knife-edge. To prevent the grip-head from lifting from its position these arms are connected to an equalizing lever underneath, and this in turn connects the weighing beams, where the strain is recorded in foot-pounds without any calculation on the part of the operator. The cone pulley has four sizes and is driven from a countershaft, which should not run faster than 30 or 40 revolutions per minute.




RIEHLE'S IMPROVED POWER TORSIONAL TESTING MACHINE.

This machine is constructed entirely of iron, steel and brass, and is of handsome design and finish. The levers and weighing beam are adjusted to the United States Government standard. Its general dimensions are: Extreme height, 3 ft. 10 in.; extreme length, 6 ft. 4 in.; extreme width, 3 ft.; weight, 2,100 lbs. Specimens can be 20 in. long or less; they can be 1½ in. square, or round with square ends, or of less size. The motion of the head is 12 in.; the capacity, 5,000 lbs. A modification of the design enables the power to be applied by hand, although it is considered much better to run the machine by power, if possible.

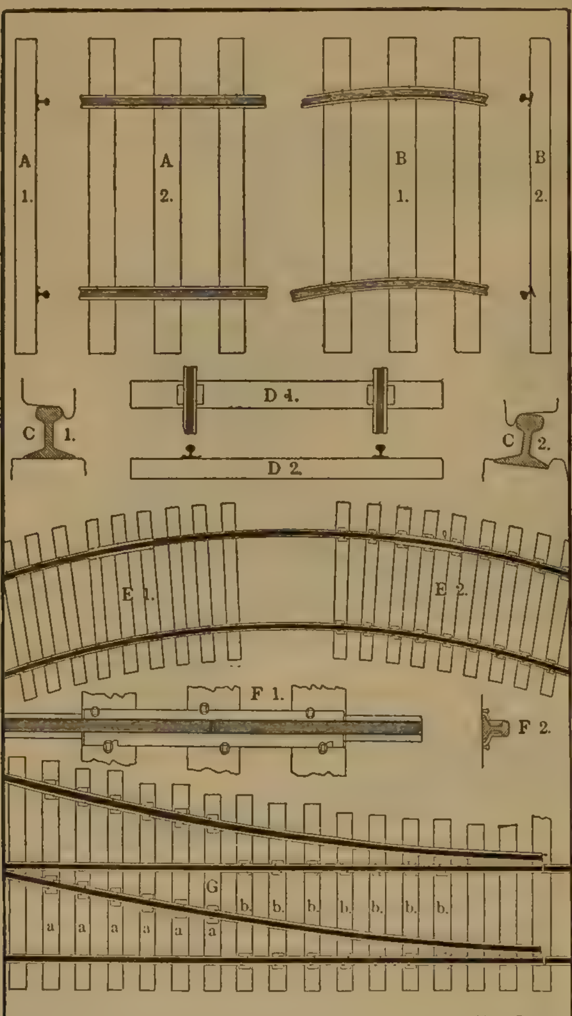
This pattern of testing machine has met with unexpected favor since the first one was completed. The makers have

furnished machines of this pattern which are now in use by the Union Pacific Railroad at Omaha; the Thomson-Houston Electric Company, Lynn, Mass.; the State College of Pennsylvania; Clark University at Worcester, Mass.; the Russian Government and the Brazilian Government.

## The Use of Tie-Plates.

MANY plans have been considered for prolonging the life of ties, the renewal of which forms so large an item in the expense of maintaining a railroad. In many parts of the country it is difficult to get hard-wood ties, while in others local causes lead to rapid decay. The different processes of wood preservation have not come into general use, and in any case they would not prevent one cause of the rapid deterioration of the tie, the cutting of the rail.

One of the most effectual devices that has so far been brought into use is the use of the tie-plate, or flat plate of metal interposed between the tie and the rail. The use and advantage of this may be illustrated by the accompanying sketches, where they are shown in special positions. In many cases extra spikes




are driven to prevent spreading of the rails, and when the wheels are on the same the rails tend to cant as shown in *A*1 and *A*2. On curves, especially where soft-wood ties are used, there is a tendency for the inner rail to turn over, as shown in *B*1 and *B*2. This tendency widens the gauge and causes more or less danger of derailment of trains. Where a tie-plate is used, as shown in *D*1 and *D*2, the tie will not be cut by the rail-base, the gauge will be preserved and the rail-head will be in correct position to give a good bearing to the wheels, as shown in *C*1, instead of cutting into the tie, widening the gauge and destroying the tie, as shown at *C*2. Another case of the use of the tie-plate is shown at *F*1, on heavy grades and with the outside rail on curves, where the slot in the inside angle-bar frequently wears rounding, allowing the spike to slip out of and by the slot, and permitting the rail to move. In fig. *E*1 a case of this kind is shown, where the rail has moved, carrying the ties with it, making the support uneven and throwing the track out of line. This necessarily caused more or less oscillation to the train and at the same time increased repair to track. Where the tie-plate is used, as in fig. *E*2, the ties remain in place and little or no movement of the rail is possible. If the tie-plate is made of the proper length and the holes for the spikes punched directly to agree with the slot holes in the angle-bar the spikes will afford material help in keeping the rails in place and upright.

All who have had to do with the maintenance of track will appreciate the use of tie-plates in switches. Fig. *G* illustrates this. Where the main traffic comes on the curved rails the plates should be placed as shown in *a a a*, but where the straight track is the main track, they should be placed as shown in *b b b*. Their use is further desirable in this case, as they tend to prolong the life of the switch ties, which are of unusual length, and generally much more expensive than the ordinary ties.

It is to meet this demand for support to the rail that the Servis tie-plate has been devised. It is rolled of steel and provided with a flange which prevents it from buckling under the rail so that it becomes practically a part of the tie. By giving an extended bearing it prevents cutting of the ties, as noted above, and preserves their surface, its own stiffness being secured by the flanges. As at present made, the plate is rolled in two sizes, 3¾ × 8 in. and 6 × 8 in., which have been found most convenient for general use. Some recent experimental tests with this plate have given remarkable results. In these tests, which were made at the Illinois Steel Works, a rail fastened to a seasoned oak tie with two spikes required a pressure of 5,000 lbs. to spread the gauge ¼ in., while the tie-plate moved but ⅛ in., the inside spike lifting when the rail was subjected to a pressure of 11,230 lbs.; for the standard rail-brace with three extra spikes a force of 17,400 lbs. was required, showing the tie-plate to be equivalent to a rail brace at every other tie. In tests with cedar ties made at Watertown, Mass., a rail fastened with two spikes showed a resistance of 1,267 lbs.; the Servis tie-plate with two spikes showed 7,910 lbs., while the rail-brace with three extra spikes gave 9,200 lbs., or only 16 per cent. more than the tie-plate. It is well to note that cedar ties with the tie-plate offered nearly 80 per cent. more resistance than the two spikes in seasoned white oak.

The Servis tie-plate has recently been adopted in two places where there is extraordinary wear of rails. One of these is on the Louisville Bridge over the Ohio River, and the other on the Manhattan Elevated Railroad in New York, where the track is subjected to as severe wear as on any line in the world.

It is claimed by the manufacturers of the Servis plate—the Dunham Manufacturing Company—that its use will save one renewal of ties; that is, that two sets of ties will wear as long as three without the plate. In this case, if the ties cost 30 cents each, the saving will be $660 per mile, as the renewal of ties, including the labor of replacing them, and taking 2,640 to the mile, will cost $1,056, while the cost of 5,280 tie-plates at 7½ cents each would be $396 per mile. Where the traffic of a road is comparatively light, so that it may not be thought necessary to use these plates on every tie, they can be used to great advantage at exceptional points, as on curves, grades, etc., as indicated above.

## The Witherow Blowing Engine.

THE accompanying illustrations—for which and the description we are indebted to the *American Manufacturer*—show an improved pattern of blowing engine built by Mr. J. P. Witherow, of Pittsburgh, at his shops, which are in New Castle, Pa. Fig. 1 shows a one-half side elevation of the engine; fig. 2 a one-half section; fig. 3 a front elevation and fig. 4 an enlarged perspective view of the inlet steam valve.

The general design of the engines, it will be seen, does not vary from that already in common use, but there are some de-


Fig. 4.

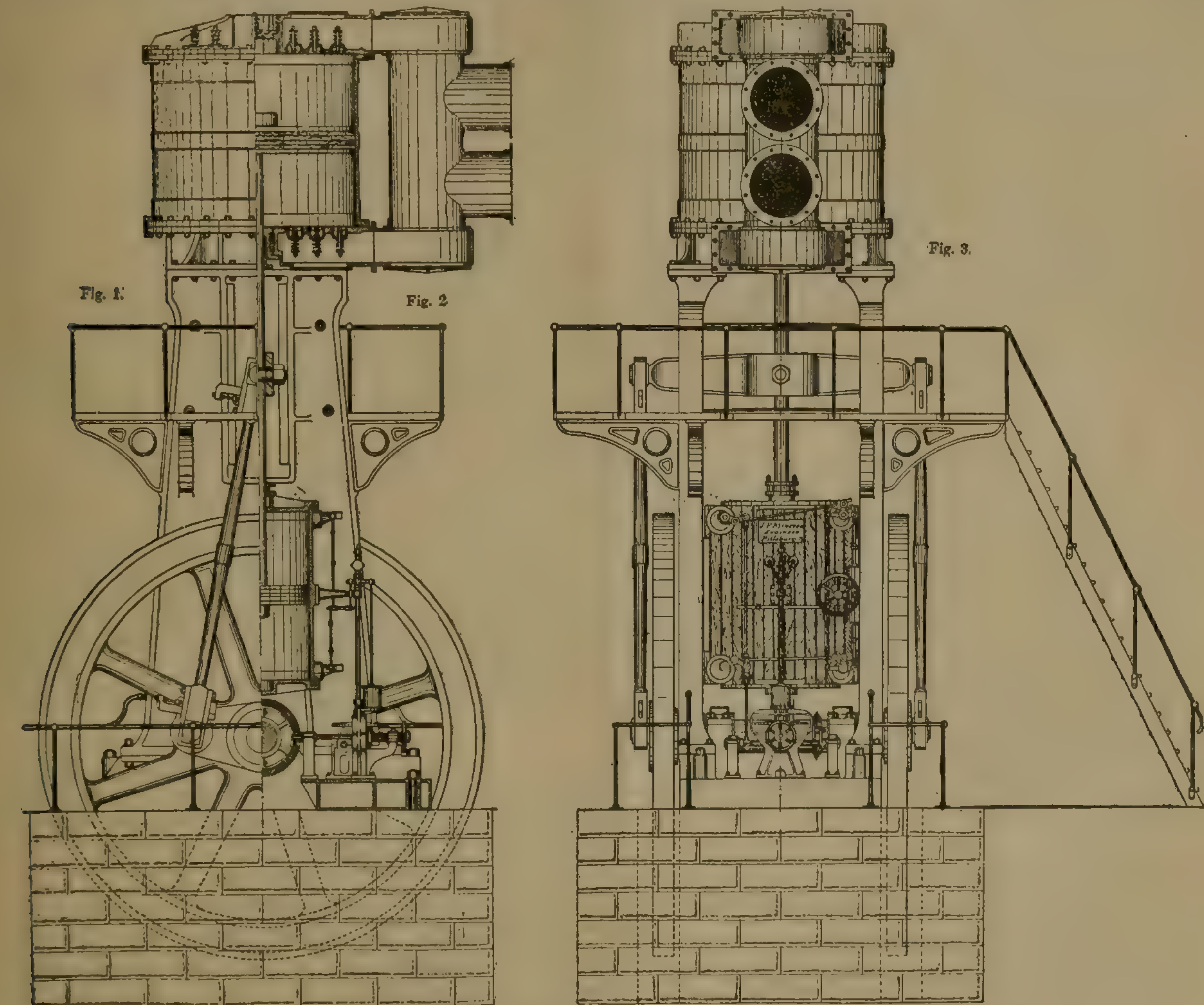
tails in the construction which it is believed add materially to their value and economy in operation, notably among which is the valves for the steam cylinders, which it will be observed from an inspection of the drawings are of the Wheelock type. This will be described in detail below.

The general dimensions of the engines are as follows: Steam cylinders, 42 in. diameter; air cylinders, 84 in. diameter by 60 in. stroke; crank shaft, 14 in. in diameter; height (from floor line), 28 ft. 6 in.; weight, 89 tons.

The steam inlet valve referred to above is shown in fig. 4. The valve seat is of the gridiron type, the valve itself being a flat slide with opening corresponding to those in the seat. The valve is operated by means of a knuckle-joint movement, by the use of which very slight lap is needed, and almost instantaneous opening and closing are secured with great ease of action under the greatest pressure. The movement of the valves under consideration is only $\frac{5}{8}$ in. The valves are fitted to separate seats driven into holes in the cylinder a little tapering, no bonnets being used.

The advantages claimed for this valve are its adaptability to high speed, tightness and freedom from necessity of balancing, positiveness of action and the entire avoidance of wear on the cylinder when in use, all of the work on them being completed before they are placed in position.

Thirteen of these engines are contracted for or now in course of building. Three are in position at the works of the Florence Cotton & Iron Company, Florence, Ala.; the others will soon be shipped to Middleborough, Bristol, and other places.



THE WITHEROW BLOWING ENGINE.

## OBITUARY.

Colonel William H. Paine died suddenly in Cleveland, O., December 31, of heart disease. He was born in Chester, N. H., in 1828, and after an ordinary school education and a short course in engineering he found employment as a land surveyor in Wisconsin, then a new country. From Wisconsin he went to California, and after engaging for a short time in mining, in 1849 he made surveys for a wagon road across the Rocky Mountains. In 1853 he had charge of a party which surveyed the first line across the Sierra Nevada for a Pacific Railroad. When the war broke out he entered the Fourth Wisconsin Regiment, but was appointed to the Engineer Corps, where he remained throughout the war, being employed constantly in preparing maps and other important work. After the close of the war, he resigned, and in 1869 was chosen Assistant Engineer of the Brooklyn Bridge, and in that capacity assisted Mr. Roebling in making the original surveys, superintended the building and placing of the caissons, the building of the New York tower and the laying of the superstructure. He also planned the whole system of cable traction on the bridge. After its completion he resigned and occupied himself as Consulting Engineer, chiefly in connection with cable railroads. He planned and superintended the construction of the cable road on 125th Street and Amsterdam Avenue, in New York City, and prepared the plans for the cable road on the Third Avenue Line, which are shortly to be carried out. He also superintended the building of the cable roads in Denver, Kansas City and Omaha, and at the time of his death was engaged in building a cable road in Cleveland, which is now almost completed. He leaves a wife and two daughters. He was a prominent member of the American Society of Civil Engineers, and was highly esteemed by his associates.

Selah Chamberlain, who died in Cleveland, Ohio, December 27, age 78 years, was born in Vermont, and for a short time was a clerk in Boston. When but 24 years old he went to Pennsylvania, where he secured a contract on the extension of the Pennsylvania Canal. He afterward built the Ohio & Pennsylvania Canal and later part of the Wabash & Erie Canal. In 1845 he went to Canada and took a contract for building part of the canals along the St. Lawrence River. When this work was completed he built a portion of the Rutland Railroad in Vermont and later the Ogdensburg & Lake Champlain Road in New York. After completing the latter he went to Cleveland and took the contract for building the entire line of the Cleveland & Pittsburgh Railroad, which was finished in 1851. He then went West and was for a number of years engaged in railroad building there. He constructed and was

largely interested in the Minnesota Central, the La Crosse & Milwaukee, the Southern Minnesota, the Hastings & Dakota and other roads. He held large interests in all of these and was chiefly instrumental in bringing about the consolidation which formed the present Chicago, Milwaukee & St. Paul Company. In 1871 he returned to Ohio and took his last contract, the construction of the Lake Shore & Tuscarawas Valley Railroad, which was later reorganized as the Cleveland, Lorain & Wheeling. He remained President of the Company until his death, and was also interested in a number of manufacturing and other enterprises. Mr. Chamberlain was one of the largest and most successful railroad contractors in the country, and leaves a considerable fortune.

COLONEL J. M. EDDY, who died in Pasadena, Cal., January 12, aged 46 years, was born in St. Charles, Ill., and began railroad work when 23 years old, as an assistant engineer on the Union Pacific. In 1872 he was appointed Superintendent of Construction on the Texas & Pacific. Later he held the same position and afterward that of General Superintendent of the Missouri, Kansas & Texas. In 1882 he was made General Superintendent of the Texas & Pacific, and in the following year General Manager of the Omaha Belt Line. In 1888 he went back to Texas as General Manager of the International & Great Northern, and there remained until recently, when he was appointed Receiver. He went to California a short time ago on account of ill health.

WILLIAM JOHN, a well-known English naval architect, died suddenly in Madrid, December 28. Mr. John was at one time a constructor in the Navy, and was afterward for several years Chief Engineer of the ship-building works at Barrow-in-Furness. At the time of his death, we believe, he was engaged in some work for the Spanish Government. Mr. John was known in this country as the engineer who furnished the plans for the battle-ship *Texas*, which is now building at Norfolk.

## PERSONALS.

JOHN F. O'BRIEN is now Superintendent of the Louisville Southern Railroad.

THOMAS THOMPSON has been appointed Railroad Commissioner of Wisconsin.

EVERETT E. STONE is now Roadmaster of the Second Division of the Boston & Albany Railroad.

M. H. ROGERS has been appointed Chief Engineer of the Denver & Rio Grande Railroad, with office in Denver, Col.

GEORGE B. HAZLEHURST is now General Superintendent of Motive Power of all the lines of the Baltimore & Ohio Railroad Company. His office is in Baltimore.

MAJOR JAMES W. WILSON has resigned his position as Superintendent and Chief Engineer of the Knoxville, Cumberland Gap & Louisville Railroad.

HON. ALDACE F. WALKER has been chosen Chairman of the Advisory Board of the new Western Traffic Association. Mr. Walker made an excellent record as a member of the Interstate Commerce Commission.

STACY B. OPDYKE, Jr., late General Superintendent of the Central New England & Western Railroad, has entered into partnership with M. BENNER as contractors and bridge engineers, at 226 South Fourth Street, Philadelphia.

SIR JOSEPH HICKSON has resigned his position as General Manager of the Grand Trunk Railway. He has been connected with the road for 29 years, for 17 of which he has been General Manager. His successor is L. J. SEARGEANT, late Traffic Manager.

THEODORE LANE is now Engineer of Maintenance of Way of all lines of the Norfolk & Western Railroad east of Roanoke, and G. M. THOMPSON of all lines west of Roanoke. R. P. C. SANDERSON is Superintendent of Motive Power of the Western Division of the road.

A. M. TUCKER is now General Manager of the New York, Pennsylvania & Ohio and the Chicago & Erie Divisions of the New York, Lake Erie & Western Railroad. J. C. MOOREHEAD is General Superintendent of those divisions, and J. H. BARRETT is General Superintendent of the Erie Division.

C. F. MEEK has resigned his position as General Manager of the Mountain Division of the Union Pacific to take charge of the affairs of a new electric light, power and railroad company in the City of Mexico. Mr. Meek's successor on the Union Pacific is W. H. BANCROFT, recently Division Superintendent.

BRIGADIER-GENERAL S. V. BENET has been relieved from duty as Chief of Ordnance of the United States Army and placed on the retired list, having reached the statutory limit of age. He was born in Florida, graduated from West Point in 1849, and was then appointed Second Lieutenant in the Ordnance Department. He has, therefore, seen 41 continuous years of service in that department; he has been Chief for 16 years, having been promoted to that position in June, 1874. General Benet's successor is COLONEL DANIEL W. FLAGLER.

THE following recent navy orders affecting the Engineer Corps are noted: PASSED ASSISTANT ENGINEER HERSCHEL MAIN has been detached from the Navy Yard, New York, and ordered to the *Boston*; PASSED ASSISTANT ENGINEER GEORGE S. WILLITS from the Naval Academy to the Cramp yards, Philadelphia; ASSISTANT ENGINEER WILLIAM D. WEAVER from the *Boston* to the Navy Yard, New York; ASSISTANT ENGINEER JOHN L. GOW from the *Fortune* to the Naval Academy; ASSISTANT ENGINEER WARD P. WINCHELL from the Bureau of Steam Engineering to the *Fortune*.

## PROCEEDINGS OF SOCIETIES.

**American Society of Civil Engineers.**—At the regular meeting, December 17, the Secretary announced the death of Mr. W. B. Knight.

Mr. T. G. Gribble read an interesting paper on Street Railroad Track, urging the importance of good track for a street railroad, which is too often neglected. The paper was discussed generally by members present, and in the course of a discussion Mr. Tratman presented several sections of girder rails, including those adopted for the Third Avenue and the Broadway cable roads in New York.

A REGULAR meeting was held January 7, President W. P. Shinn in the chair. After the transaction of routine business and the announcement of the deaths of Colonel W. H. Paine and Addison Connor, the subject of street railroad track was discussed orally and by written communications.

The following candidates were declared elected:

*Members:* Charles Irwin Brown, St. Louis, Mo.; Charles William Hazleton, Turners Falls, Mass.; Frederick Ellsworth Sickels, Kansas City, Mo.; George Westinghouse, Jr., Pittsburgh, Pa.

*Juniors:* Louis Douglas Fouquet, Walton, N. Y.; Clinton Levering Riggs, Baltimore, Md.

THE officers elected for 1891, as announced at the annual meeting, are as follows: President, Octave Chanute; Vice-Presidents, A. Fteley and Charles Hermany; Secretary and Librarian, Francis Collingwood; Treasurer, John Bogart; Directors, Charles B. Brush, Rudolph Hering, Clemens Herschel, Edward P. North, and S. Whinery.

**Military Service Institute.**—At the biennial meeting, at Governor's Island, January 14, Major-General Schofield was re-elected President, with the following members of the Council: General George D. Ruggles, Colonel R. P. Hughes, General M. P. Small, Colonel John Hamilton, Major A. E. Bates and Captain E. E. Wood. The subject selected for the prize essay for this year is "'Terrain' in Its Relations to Military Operations."

**New England Water-Works Association.**—At a meeting held in Boston, January 14, the following members were elected: W. W. Starr, Jr., Bridgeport, Conn.; Frank H. Mills, Woonsocket, R. I.; John D. Shippy, Holliston, Mass.; G. H. Barrus, X. H. Goodnow, S. E. Tinkham, Boston.

Frederic P. Stearns, Chief Engineer of the Massachusetts Board of Health, read a paper on the Effect of Storage on the Quality of Water, giving many interesting facts. It was accompanied by tables and analyses of water. This paper was generally discussed.

Mr. W. E. Davis described his experience in moving 700 ft. of pipe without taking the joints apart.

**Boston Society of Civil Engineers.**—At the regular monthly meeting, in Boston, December 17, Ellery C. Appleton,

Alfred W. French, Eugene J. Spencer and Elton D. Walker, were elected to membership.

Mr. Howard A. Carson, Chief Engineer of the Metropolitan System of Sewerage, gave an informal talk upon the work under his charge. With the aid of lantern views he described what had already been done on the Brighton, East Boston and Winthrop sections, and gave the costs of the same. He followed this talk with descriptions of the method of tunneling now being used under the Hudson River.

Mr. F. P. Stearns, who was one of the commission appointed to report a system of sewerage for the District of Columbia, was the next speaker. He explained the system recommended, which provides for high level intercepting sewers to take care of the water in the high districts as far as possible, leaving as small a quantity as possible to be pumped from the low districts. About 940 acres would have to be taken care of by pumping. The proposed system was estimated for a population of 500,000.

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**Engineers' Club of Philadelphia.**—At the regular meeting, December 20, Mr. Edward Hurst Brown presented a paper on Suburban Development, in which he referred particularly to the development of suburban places of residence in the vicinity of Philadelphia. There was considerable discussion by Messrs. Henry G. Morris, Robert J. Parvin, A. G. Rudderow and C. H. Ott. Mr. Morris advanced the opinion that a large building, something after the order of the Drexel building in Philadelphia, could be most advantageously used as a place of residence by families; that a city could be constructed with such places on alternate squares, arranged after the manner of the black squares on a checker-board, leaving the other spaces open for healthful breathing spaces and various purposes.

The Secretary presented, for Mr. John Graham, Jr., a paper upon the Use of a Pumping Dredge by the Norfolk Company at Norfolk, Va., and explained its use in the reclamation of low waste land in such localities. He says that the advantages of this machine seem to be its ability to transport material to a reasonable distance; celerity in dredging and removing obstacles to navigation; celerity in filling; economy in removing and depositing the material. There was some discussion by Mr. Robert J. Parvin, in which he referred to dredging work in California.

The Secretary presented, for Mr. G. R. Henderson, a paper on Crown-bar Stays, illustrated by two drawings of stays, and giving the formulas by which they were proportioned in his practice, also the results of actual tests as to strength. There was some discussion.

The Secretary presented, for Mr. Charles H. Haswell, a brief paper upon Shingle for Concrete and Beton. He is of the opinion that shingle under certain conditions is superior to broken stone in the composition of concrete and beton, both in strength and in economy of cost. There was some discussion by Dr. H. M. Chance and Mr. Howard Murphy.

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**Engineering Association of the South.**—At the regular meeting, in Nashville, Tenn., January 8, a communication was received from the Alabama State Technical & Scientific Society, acknowledging receipt of congratulations on its organization.

The following elections to membership were announced: *Members:* George B. Crafts, Atlanta, Ga.; Henry A. Turner, Birmingham, Ala. *Associate:* S. M. Newbold, Birmingham, Ala. *Juniors:* R. L. Johnson, Columbus, Ga.; Thomas B. Wilson, Jr., Harriman, Tenn.; R. A. Chapman, Sheffield, Ala.

Mr. D. W. Cooke exhibited and explained a model and drawing of a proposed system of light-draft towage boats proposed by him for western rivers. The system proposed a series or train of barges each having one convex and one concave end. The convex bow of one was intended to be fitted into the concave stern of the next ahead, in order to do away with but one cross-section resistance in moving through the water. The line of tows was proposed to be drawn by a side-wheel tug at the head of the tow, having the same cross-section and having a concave stern like the other barges. Barges carrying freight to any particular point are intended to be dropped out at way points, like freight cars from a train.

A paper entitled a Study of Steam-Engine Pistons was then presented by Professor W. T. Magruder, of Vanderbilt University. The paper, after going into an extensive discussion of the formation, dimensions, and features of steam pistons for large engines in general, drew a comparison between the best forms in practice and the piston of the Holly-Gaskill pumping engines at the Nashville Water Works, which have twice broken recently. The paper showed that it was highly improbable that the breakage had been caused by the clearance being filled with condensation water.

Mr. Landreth submitted for informal discussion a draft of a Highway Bill which was being prepared by a committee appointed by the Nashville Commercial Club for presentation to the present State Legislature. The bill provides for a State Board of Engineers composed of three members appointed by the Governor, meeting quarterly, having chiefly advisory powers, but having the right to specify and determine the qualifications of County Engineers, and the forms of records and maps by which the work of the several counties shall be recorded. The bill further places the control of each county in the hands of a commission composed of three members to be appointed by the County Court, and requires the Commissioners to place the execution of all work in the hands of a competent County Engineer, who in turn may appoint as many district superintendents as may be essential to maintain the entire road system of the county, each Superintendent being required to devote his whole time to his district, thus securing the *maintenance* of highways rather than their periodical repair. The proposed bill abolishes the civil district or township lines in the collection and expenditure of taxes, thus making the county the unit, and giving each county the option to abolish the road labor system, by reducing the number of days to be assessed each resident to zero if desired. The bill does not increase the road tax above that of the past few years, but in fact substantially reduces it by placing the maximum number of days' labor at eight in place of 12 days, as at present.

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**Western Society of Engineers.**—At the annual meeting, in Chicago, January 7, there was a large attendance. The following officers were elected for the ensuing year: President, L. E. Cooley; Vice-Presidents, J. F. Wallace and J. O. Seymour; Secretary, John W. Weston; Trustee, O. Chanute.

Mr. Cooley delivered the annual address, in which he called attention to the duties of the engineer as a citizen toward the general community.

The meeting was followed by the annual banquet, at which about 200 members and guests were present.

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**Engineers' Club of Cincinnati.**—The third annual meeting was held December 18, and was well attended. Thomas H. Kennedy and Claude Freeman were elected members. The Secretary reported the total number of members at date 96, and the average attendance at meetings during the year $25\frac{6}{11}$. A paper was read at each meeting, and on one night a budget of six short papers. The Treasurer's report showed the Club to be out of debt with a satisfactory balance in the treasury.

The following officers were elected: President, Robert L. Read; Vice-President, Ward Baldwin; Directors, Epes Randolph, W. B. Ruggles and S. Whinery; Secretary, Treasurer and Librarian, J. F. Wilson.

The retiring President, Mr. G. B. Nicholson, read a very interesting address in which he reviewed the history of the club, the progress made since its organization, on which he congratulated the members, and its condition at the present time. He urged upon the club the desirability of procuring permanent quarters and the establishment of a library. His address concluded with a short description of the works of engineering interest in and about Cincinnati.

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**Engineering Association of the Southwest.**—The regular December meeting was held in Birmingham, Ala. The proposed amendment to the Constitution was carried, and the Association will be known henceforth as the Engineering Association of the South.

Mr. A. B. Gude presented a paper on the Georgia Pacific Railroad Bridge over the Yazoo River, describing the construction of the bridge, the special point of interest being the manner of constructing the pier for the draw-span, which was done by driving a large cluster of cypress piles, sawing them off even with the bed of the river, and then placing on top an octagonal grillage of three courses of timbers bolted together, on top of which the masonry was constructed.

A paper on the professional Status of Engineers was read by Mr. William G. Williamson. It treated of abuses in the engineering profession, and of the principles which should control the business relations of engineers with each other and with the public.

On the day following the meeting the members visited the mines and rolling mills at Birmingham, Bessemer and in the neighborhood.

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**Michigan Engineering Society.**—The twelfth annual convention was held at Lansing, January 20–23, when a number of papers were presented and discussed, among them the following: W. B. Sears, Rapid and Accurate Surveying; F. Hodg-

man, That Problem in Surveying, and that Fallacy of the Gradienters; M. E. Cooley, Experiments on Water Motors; N. F. Durand, Behavior of Wood under Stresses; Josiah Ripley, Submarine Work.

The officers of the Society are: President, J. B. Davis; Vice-President, George L. Wells; Secretary and Treasurer, F. Hodgman; Directors, George E. Steele, M. E. Cooley, C. E. Greene.

**Iowa Civil Engineers & Surveyors' Society.**—The Fourth Annual Convention met in the City Hall, in Des Moines, December 30, with a good attendance of members. The Secretary read a number of letters from absent members, which were of interest to the Society.

The retiring President, Mr. E. M. Gilchrist, then delivered the annual address, which was filled with good suggestions for practical work. The reports of the Secretary and Treasurer showed a slight increase of membership, a small balance in the treasury and a material growth of the library.

The Executive Committee reported the following persons elected to membership: M. V. Ashby, Afton; A. W. Heald, Hawarden; Edward S. Hyde, Paul Ilg, Dubuque; L. Higgins, Des Moines. Messrs. R. S. Finkbine and R. L. Chase, of the Board of Public Works, Des Moines, were elected honorary members of the Society.

The following officers were elected for the ensuing year: President, M. Tschirgi, Jr., Dubuque; Vice-President, William Steyh, Burlington; Secretary and Treasurer, Seth Dean, Glenwood.

A number of papers were read on different subjects. Among others, one by R. G. Brown, of DeWitt, on the Measurement of Earthwork, and one by William Steyh, of Burlington, on Taking Notes for Municipal Improvements, were very full and interesting.

**Civil Engineers' Society of St. Paul.**—The annual meeting was held at the Hotel Ryan, January 5, President Mason in the chair; 11 members and 1 visitor present.

The minutes of the last meeting having been read and approved, the annual reports of the Secretary and Librarian were read, and, upon motion, accepted and placed on file. President Mason made some remarks appropriate to the end of the year.

The following officers were elected for the ensuing year: President, S. D. Mason; Vice-President, George L. Wilson; Secretary, C. L. Auman; Treasurer, A. O. Powell; Librarian, A. Munster; Representative of the Society on the Board of Managers of the Journal of the Association of Engineering Societies, C. J. A. Morris; Auditor, W. W. Curtis.

The literary exercise was a paper by M. A. Munster upon a Diagram and Formula giving the strength of columns according to Gordon's formula, by a shorter method.

Owing to the lateness of the hour, the discussion was postponed until the next meeting.

**Engineers' Club of St. Louis.**—At the annual meeting, December 17, the result of the ballot for officers was reported as follows: President, George Burnett; Vice-President, N. W. Eayrs; Secretary, Arthur Thacher; Treasurer, Charles W. Melcher; Librarian, J. B. Johnson; Directors, S. Bent Russell, F. E. Nipher; Managers, J. A. Seddon, J. B. Johnson.

Colonel E. B. Meier read a Memoir of the late Thomas J. Whitman, formerly President of the Club.

The retiring President, Mr. F. E. Nipher, gave an address on the progress of electrical work in St. Louis, showing what had been done in the way of electric light, motors and street railroads.

Mr. H. M. Kibby then read a paper on Cable and Electric Railroads, comparing the cost of constructing and operating street railroads by cable and by electricity. This paper called out a long discussion, in which some interesting facts and figures were given.

At the regular meeting, January 7, a committee was appointed to arrange for the purchase of the library of the late Mr. Whitman.

Mr. J. A. Seddon read a paper on the Economic Design of Settling Basins, giving an account of the best systems which could be adopted in varying conditions, while at the same time providing sufficient surface and storage to permit the water to stand long enough to permit complete settlement of the sediment, etc., and to provide proper facilities for cleaning the basins. The paper was discussed by a number of the members present.

**Northwestern Track & Bridge Association.**—At the regular December meeting in St. Paul, Minn., a paper was read on the Best Time and Place for Renewing Ties, by Mr. McCutcheon, which was generally discussed by members present, a variety of opinions being expressed.

Mr. E. J. Pearson then read an interesting paper on Temporary Expedients in Case of Fire and Wash-outs, giving description of a number of ways of building temporary trestles and bridges to replace track or water-crossings destroyed, and describing especially the methods in use on the Northern Pacific Road.

**Montana Society of Civil Engineers.**—At the regular December meeting in Helena, Mont., the Committee appointed to select the representative to serve on the Committee of Arrangements for the International Engineering Congress in 1893 recommended Mr. Elliott H. Wilson. This action was approved. The Committee of Arrangements for the annual meeting reported progress stating that the first day of the meeting would be spent at Marysville visiting the works there.

A paper by Mr. S. J. Jones on the Arithometer was read showing the advantages of the use of this machine upon certain classes of calculations, demonstrations being made on a machine loaned for the purpose. This device is of French invention and is capable of multiplying 16 figures in the multiplicand by eight figures in the multiplier, and performing division with equal facility. It has been in constant use in the Mineral Department of the United States Surveyor General's office for Montana for about four years, mainly upon traverse calculations, and accomplishes results in much less time than is practicable by the use of logarithmic or traverse tables.

**New England Railroad Club.**—At the regular meeting in Boston, January 14, the topic for discussion was "What Constitutes a Defect in a Vertical Plane Coupler Sufficient to Condemn the Coupler?" There was a very lively discussion, the speakers being Messrs. F. D. Adams, J. W. Marden, John J. Chamberlin, S. M. Butler, W. J. Robertson, J. N. Lauder, Albert Griggs, J. H. Barnes and others. A number of speakers raised objections to the vertical plane couplers principally on account of the fact that the knuckles are so easily broken, entailing expense for repairs, and partly also on account of the difficulty in coupling them with the ordinary link and pin coupler.

The subject for the February meeting is Painting, and Master Painters are invited to meet with the Club.

**New York Railroad Club.**—At the January meeting, in New York, Mr. A. E. Mitchell, of the Erie, presented a paper on the Qualities Essential for a Free-steaming Locomotive. Mr. W. G. Wattson, of the West Shore, spoke on Car Service.

There was a large attendance at the meeting, and a lively discussion, several of the speakers giving interesting notes of experience.

**Master Mechanics' Association.**—It is announced that the Annual Convention will be held at Cape May, N. J., beginning Tuesday, June 16. The headquarters of the Association will be at the Stockton Hotel.

**Master Car Builders' Association.**—The Executive Committee announced that the next Annual Convention will be held at Cape May, N. J., beginning Tuesday, June 9. The headquarters will be at Stockton Hotel, which has made a uniform rate of $3. per day. Messrs. Blackall, Lentz and Kells are the Committee on Headquarters.

## NOTES AND NEWS.

**Petroleum as a Locomotive Fuel.**—A correspondent informs us that many of the locomotives of the Argentine Great Western Railroad are being fitted for the use of petroleum as fuel, and it will probably supersede all other fuel on that road. The oil used is a heavy petroleum found at Mendoza, near the line of the road, which answers the purpose of fuel fairly well, although it has been found impossible to refine it so as to make a good lamp oil. The economy is very considerable, as the railroad company can procure this oil at present at a cost of $12 paper per ton—equivalent to about $3 gold—while English coal, which has been used on parts of the line, costs $20 gold per ton. Fuel is very scarce in the country.

Our correspondent adds that until more economical methods are adopted in operating railroads, the Argentine Republic will never be able to compete with the United States in the grain markets of the world, as it will be impossible to give grain producers low rates to a seaport.

**The Albert Bridge at Belfast.**—The accompanying illustration, from the London *Engineer*, shows a new street bridge—named the Albert Bridge—over the Lagan River at Belfast, Ireland, which was recently completed from the designs of Mr. J. C. Bretland. The bridge consists of three arches, each made up of 11 cast-iron ribs. The radius of the intrados of the center arch is 99 ft. 10 in., and the intrados of each of the shore

arches is 107 ft. 7 in. The segments forming each arched rib, both of the center and the shore arches, are five in number. Each segment of the cast-iron ribs, both of the center and the shore arches, has intermediate radial stiffeners. All butting surfaces of the segments were planed to radial lines, and most accurately gauged in the workshop to ascertain that these surfaces were perfectly true. No bolt holes were cast, but in all cases they were drilled, and all bosses faced. All bolts, either for joints or for connecting the wrought-iron work, were turned to an exact fit. On the upper flange, and in the positions required, are cast the lugs to which the spandrel pillars and longitudinal girders are to be secured. The pivots are of cast iron.

The contract for the construction of the bridge was taken by Messrs. Henry, of Belfast, for £36,500. The ironwork was supplied by Handyside & Company, Derby, England, the granate being prepared in the quarries at Dalbeattie.

**Compound Locomotives in Ireland.**—The Worsdell-von Borries-La Page compound engines, which have been recently added to the locomotive stock of the Belfast & Northern Counties Railway, it is said, are giving every satisfaction and working with marked economy. Most careful tests are being made with a view to show accurately the economy of the compound engine over the simple. The engines were built by Messrs. Beyer, Peacock & Company, Limited, of Manchester.

**A New Method of Tunneling.**—In the construction of the tunnel which is being made for the new main line of the Great Northern Railway Company, in connection with its Metropolitan traffic from King's Cross, a new method of tunneling, the apparatus for which is the invention of Messrs. Jennings & Stannard, Victoria Street, Westminster, is being used. The invention is to facilitate the construction of tunnels, subways, and sewers in cases where it is necessary to support the superincumbent earth, and to prevent subsequent subsidence of the surface. The most frequent cause of subsidence is due to the fact that, to admit of the usual system of timbering, ground above the limits of the permanent brickwork is disturbed or removed, as shown in fig. 1; and as it is seldom thoroughly replaced by packing as solid as the original ground, settlement ensues sooner or later. This new method of tunneling obviates this, as by its use no ground outside the actual section of the subway need be disturbed.

The invention comprises the design and arrangement of a series of steel bars or "needles," which are placed side by side within the excavation, so as to form a complete temporary lining and support to the roof. Within this series of needles the permanent brick arch of the tunnel is built, as shown by fig. 2. The needles used in this work are 10 ft. long, 6 in. wide, and 2 in. thick. They are of sections like those illustrated by fig. 3, and are provided with longitudinal grooves, by means of which each needle is linked to the next one in such a way as to admit of separate longitudinal motion.

The needles are inserted and supported in the same manner as ordinary tunnel bars, the ground being excavated only to the exact section of the tunnel—plus the trifling thickness of the needles. After the brickwork has been built within them the needles are separately pushed forward by screw-jacks, as the ground is excavated for the succeeding length.

The needles are provided with longitudinal tubular cavities, through which grouting or other filling material may be introduced from time to time to fill the space left vacant by the advancing needles between the top of the lining arch and the earth above and around, and this prevents any subsidence. A great saving is effected in the quantity of excavation necessary in the present mode of carrying out works of this description, as by this mode no crown bars or poling boards, as in fig. 1, are necessary, and the excavation is only taken out the size of the brickwork to be built, as in fig. 2, thereby preventing waste of timber or the extra brickwork generally built between crown bars or timbers. In driving sewers, the exact shape of the sewer can be taken out, instead of driving a square heading.

It will not be so often necessary to break up the surface of roads for the construction of subways or passages, as with this method there need be a thickness of only a few feet above the crown of the arch. At King's Cross the heavy goods yard is tunneled by this method to within less than 3 ft. of turntable foundations, the traffic being unimpeded. Part of the work

Fig. 1.

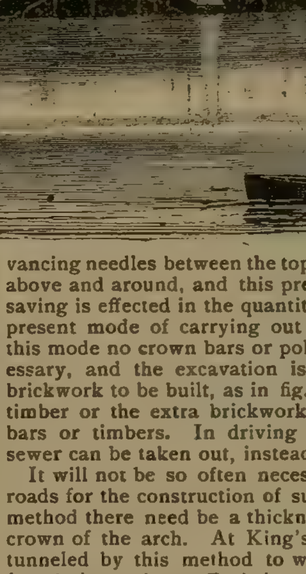
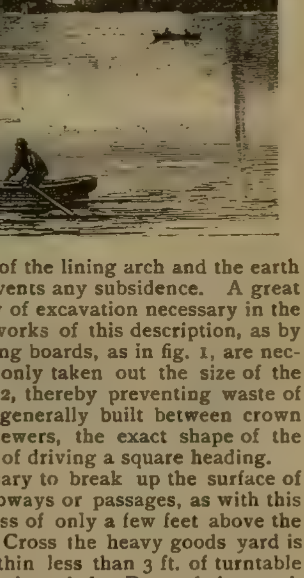
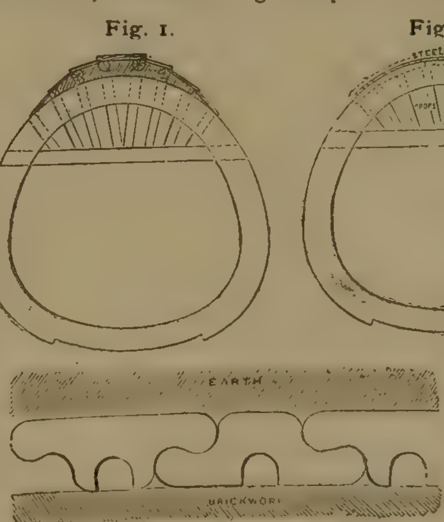


Fig. 2.



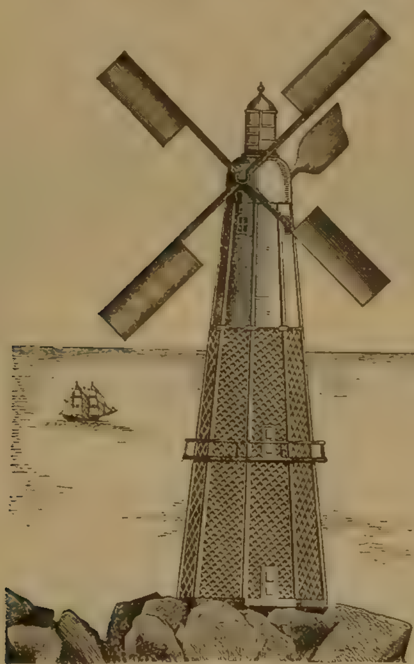

SECTION OF NEEDLES

Fig. 3.

would have had to be done in open cutting and traffic stopped, but for this system of working, which saves 3 ft. of headway. A great saving of time is effected by this method. The steel needles will, of course, last many years, and will suit any shape of arch. At the King's Cross tunnel, experience has shown that, besides a great saving of time, there has been a reduction, as compared with the usual method, of about 50 per cent. in the cost of all that part of the work which is affected by the new method—that is, from the crown to the top sill of the face timbering, below which the work is executed in the ordinary manner.—*The London Engineer.*

**An Electrical Lighthouse.**—The accompanying illustration, which is from the report of United States Consul Connolly, of Auckland, New Zealand, to the State Department, shows a lighthouse devised by Mr. Hannaford, a New Zealand inventor. It is an iron tower, with a windmill attached, which furnishes power to run the electric light, storage batteries being provided to equalize the power and secure a regular, uniform light at all times. The inventor describes its working as follows:

"The Hannaford light is in three tiers up to the revolving cupola (which carries the lamp), but, although the lamp, of



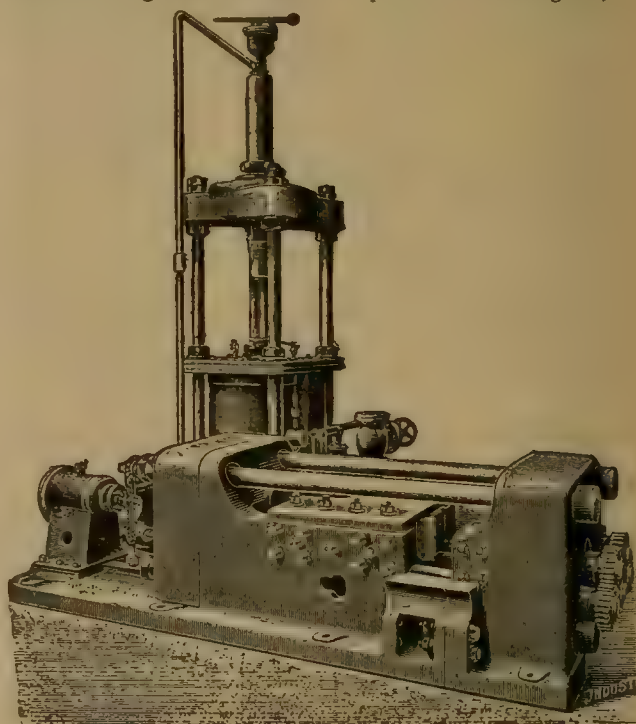
course, revolves with the cupola, the arc within does not, but is always broadside to one desired direction, the lens pulley at its back facing (that is, the back of the lens) the land. Now, the lens has spring slides, which, when operated, send electric flashes that can be plainly discerned a distance of at least 30 miles inland. Each set of flashes are different from each other and represent the letters of the alphabet. An expert within the lighthouse can communicate to an expert many miles inland anything of importance—a supreme value in the event of a marine disaster or in war time. Again, the arc can be bent downward and upward, swayed to right or left, or all round the compass, thus making it a great ocean searcher. Again, the arc is automatic, does its own lighting and extinguishment to an hour, a minute, or a second. The storage of electricity is so novel that it is absolutely impossible to run short, even for an hour, of the full strength of the 15,000 candle-power, not even if there were a dead calm of six months' duration. Now, the illustration of the external appearance of Hannaford's light which I inclose would be misleading without explanation. There is, in reality, no lattice ironwork in the base and central tiers; on the contrary, they would be like the top tier. It was necessary to introduce this lattice work in the working model so as to be able to observe the internal arrangements of the tower."

The advantages claimed are cheapness, durability, simplicity of construction and the ease with which the lighthouse can be erected or, if necessary, taken down and removed.

**Steel Barrels.**—Works are to be established in Barrow, England, to make steel barrels for carrying oil. They will be rolled by special machinery, devised by Mr. David Caird.

**To Prevent Windows from Breaking.**—A French scientist says that breakage of glass in windows subject to shocks—as in the neighborhood of mines or quarries where heavy blasts are set off, or near forts where there is practice with heavy guns—may be prevented by pasting on the glass strips of paper crossing each other in different directions. These will prevent or stop the vibrations produced by a shock, which are the cause of breakage of the glass.

**Hydraulic Shears Combined with a Steam Intensifier.**—A system of working hydraulic shears and other presses by steam intensifiers has been developed on a large scale in Germany by Mr. R. M. Daelen, of Düsseldorf, Messrs. Breuer, Schumacher & Company, Kalk, Cologne, being the manufacturers. It is claimed that it has proved both simple and economical. When hydraulic power is used for ingot shears, and forging and stamping presses, the water pressure must be very high in order to work with cylinders of small diameter. It is difficult to maintain such a distribution of water at high pressure and guard against the waste of water and the consequent loss of power. By the employment of the intensifier the distribution is carried out, and there is only a short pipe from the pump to the large cylinder of the press, so that there is no loss of water. Another difficulty of the hydraulic installations with steam pump and accumulators of high pressure is that the same presssure is used every time upon the piston of the press, while the resistance which has to be overcome is in most cases variable. This leads to a considerable loss of power. The steam intensifier works with a variable pressure, which corresponds to the resistance against the piston of the press, and this effect is obtained by regulating valves of different forms which allow the steam to be used expansively. Some doubt, which was at first expressed, that it would not be possible to work very exactly with a hydraulic piston driven by a steam multiplier, has been dispelled by employing regulating valves in the water pipe. By them the velocity of the water and of the steam piston can be so regulated as to move the piston as steadily as in a simple hydraulic press or shears. The system has been also applied by Mr. Daelen to cranes and hoists, but with lower water pressure. In this case it is very economical in installations where there are only so small a number of cranes to drive that it would be expensive to put in a steam pump and an accumulator. The first design was that of a vertical bloom shears for billets or blooms up to 6 in. square, and flat bars and slabs, while the one shown in our illustration was designed for blooms up to 15 in. and more. There are now in Germany and Austria a number of shears of both designs in use, the weight of which varies between 20 and 100 tons. The billet shears make about 24 strokes per minute, and the largest bloom shears about 12 per minute, while shears driven by a steam-engine make only four to six per minute, and the movement of the blade is not dependent upon the will of the operator, as it is in the one which we illustrate. Large bloom shears have powerful steam-engines,



which run at full speed all the time, returning as well as cutting. Steam of high pressure is used in the single-acting intensifier. There is a small cylinder upon or behind the shears, the piston of which is under steam pressure and works the shear blade. A number of presses of different kinds and sizes are now at work for other purposes, among which is a 5,000-ton press for bending armor plates. Further presses of special design for stamping rolled railroad sleepers are also at work. The system has also been applied to forging presses up to 1,200 tons pressure. The cranes and hoists have chiefly been employed in open-hearth steel works.—*Industries.*

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NEW YORK, MARCH, 1891.

THE deaths of the Admiral of the Navy and the General of the Army, coming close together, remove at once almost the last of those who held high command during the late war. General Sherman had been actually retired from service for some time, and Admiral Porter's health had prevented him from exercising command for several years, so that neither had taken an active part in the later developments of the two services. Both played great parts when there was need of their services, and both owed their high rank to pre-eminent merit as leaders on land and by sea.

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THE complete statistics gathered by the American Iron & Steel Association show that the total production of pig iron in the United States, in 1890, was 10,307,028 net tons of 2,000 tons. This is an increase of 1,790,949 tons or a little over 20 per cent. over 1889, and was the largest output ever reported in the United States in a single year. The production was pretty equally distributed throughout the year, the second half showing only about 90,000 tons more than the first. Of the total production 703,522 tons were made with charcoal as a fuel; 2,448,781 tons with anthracite coal, and the remaining 7,154,725 tons with bituminous coal or coke. This classification is not altogether strict, as in many anthracite furnaces coke is used with the coal. Of the total production 4,583,424 tons are classed as Bessemer pig—that is, iron adapted for the manufacture of steel. This great output entered very largely into consumption, as the stocks reported unsold at the close of the year were less than 700,000 tons.

This production puts the United States at the head of the iron-producing countries, as it has passed Great Britain in the quantity of iron yearly made.

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IT is hardly likely that 1891 will show as large a production as 1890. The February report compiled by the *American Manufacturer* shows a considerable falling off in the furnaces in blast. On February 1 there were 274 furnaces running, the weekly capacity of which was 139,340 tons, which is a decrease of 32 furnaces in number and of 24,942 tons in weekly capacity since January 1. The falling off is pretty generally distributed and is not all in one district. The furnaces which have gone out of blast were in both Eastern and Western Pennsylvania, Ohio, Virginia, West Virginia, and Michigan. The Southern furnaces remain about the same, one or two in Alabama and Georgia having stopped for repairs, but their places were taken by others.

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NO bids were received at the Navy Department for the fast torpedo cruiser, for which bids were asked some time ago to be sent in February. This result was not unexpected, as the price fixed by law was hardly sufficient to pay for the construction of the vessel required. To attain the speed of 23 knots, which was specified, on so small a displacement as was required in this case, is not a very easy matter, and would make it necessary to build a very expensive vessel with enormous engine power in proportion to tonnage and considerable structural strength to enable her to carry the engines. New proposals may be advertised for, but it is quite probable that no further action will be taken unless Congress modifies the law so as to permit the offer of an increased price or a lowering of the speed conditions.

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AN application has been made to Congress to authorize the guarantee by the United States of $100,000,000 bonds of the Nicaraugua Canal Company. The bill has met with considerable favor, but its passage is still in doubt, owing to the great press of business at the short session, and the little time remaining which would enable its opponents to prevent its passage, even if they should prove to be in a minority. The arguments in favor of the proposition are that it will be very difficult to procure the money for the construction of the Canal in this country without some such action, and that it will be very much to the disadvantage of the United States to have the Canal built with foreign capital. Its control is a matter of great importance to this country, and to allow it to pass into the hands of a foreign Government would be extremely unwise. That the Canal itself is entirely practicable is now fully established, and the only question remaining to be considered is that of ways and means. Should the proposal for a guarantee fail in the present Congress, it will undoubtedly be brought forward in the next, and with considerable prospect of success.

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IN his recent annual message, the Governor of Missouri makes a strong appeal for better wagon roads. He refers to the condition of the roads generally throughout the State, and speaks of the cost to the farmer of poor roads, and the great advantages of improving their condition. Nothing, he says, would be more beneficial to the State at large than a comprehensive system of good roads. It is hoped that the Legislature will act on this suggestion and will take some steps for the improvement of the highways of the State.

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IT is reported that the Grand Trunk Company purposes building a new bridge over the Niagara River near the present suspension bridge. The latter is to be retained for passenger trains only, and the new structure used for freight purposes, the suspension bridge being considered insufficient for the present traffic of the road. Plans for a stone arch bridge have been prepared by Mr. L. L. Buck,

and it is said that his estimates are so low that the stone bridge will probably be constructed.

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THE Commission appointed by Congress to select a site for a new dry dock on the Pacific Coast has recommended Point Turner at Port Orchard, in Puget Sound, as the site, thus repeating the recommendation made some time ago by a committee of Naval Officers. The present Commission includes army and navy officers and civilians, and its members have made a careful examination of the coast and bays of Oregon and Washington.

It is to be hoped that Congress will endorse this recommendation by a prompt appropriation, and that provision also will be made for building up a navy yard at the same point. The only yard on the Pacific Coast at present is at Mare Island, and it is certainly necessary to supplement that by another, especially when we consider the growing importance of Puget Sound and the waters to the northward.

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THE New York, New Haven & Hartford Company, which has heretofore steadily opposed the introduction of continuous heating on its trains, has at last decided to adopt it, having closed a contract with the Consolidated Car Heating Company, of Albany, to equip at once a large number of cars. The system to be used is the "consolidated disk drum," which is to be used to heat the water in the Baker heater pipes already in the cars. The Sewall coupler will be used for the steam pipes.

In justice to the New Haven Company, it may be said that this change is not the result of public pressure arising from the recent accident in New York, as negotiations for the use of this system had been going on for some weeks before the accident.

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DURING its last fiscal year the Baltimore & Ohio Company made a considerable advance both in traffic and earnings, and had upon the whole the most prosperous year for some time past. The improvements made in the road and equipment are very considerable, and more are in prospect. These include the construction of several large storage yards and freight stations at different points and considerable additions to the stock of locomotives and cars. The freight for New York is now handled entirely from the Staten Island terminus.

The Company has made and is making some additions to its mileage. These include the purchase and construction of three short lines in Western Maryland and West Virginia, which will bring a considerable amount of mineral traffic to the road. To the eastward the Company has completed the Baltimore & Eastern Shore Railroad, which, in connection with the Annapolis Short Line, makes a more direct and shorter connection between Baltimore and the Eastern Shore than has heretofore existed. The most important acquisition of mileage during the year, however, was the controlling interest in the Valley Railroad, from Valley Junction to Cleveland, and the construction of the line from Akron to Chicago Junction, which will shorten considerably the Company's line to Chicago. The last-named line is now nearly finished.

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THE terminal line of the Philadelphia & Reading Railroad in Philadelphia is to be built, the consent of the City Council having been at last secured. The plans include an elevated road crossing the streets in the busy portion of the city on bridges, and the construction of a passenger station of ample size, the building itself to be 260 × 90 ft., and the train-house 260 × 575 ft. This will be a great relief to the city in freeing the streets from obstruction, and to the road in providing accommodations for the traffic, for which the present station is entirely inadequate.

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HOW great an obstruction to street traffic a railroad may be is shown by the statement that the number of regular trains entering and leaving the Philadelphia & Reading stations in Philadelphia is 290, of which 230 run to and from the main station at Ninth and Green streets, the remainder going to the old station at Third and Berks streets. This does not include freight trains or the crossing of the streets by switching engines. Under existing circumstances constant trouble is unavoidable, and a separation of railroad and street grades has become a necessity which could no longer be postponed.

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THE growth of our larger cities creates an enormous traffic which must be accommodated, while at the same time it makes the handling of that traffic difficult. Thus a condition has arisen in which the cost of the terminals of a road may almost equal that of the road itself. Were a new line to be built from New York to Boston, for instance, the two sections of five miles at each end of the road would probably call for a larger expenditure of money than the 200 miles or so which would make up the rest of the line.

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NO railroad running out of New York has shown a greater growth in suburban traffic during the past few years than the New York, Lake Erie & Western. The road has an excellent suburban country on its main line and branches; but the growth has been largely due to the great improvements in train service and accommodations which have been made under the present management, which has done much to repair the mistakes of previous administrations in neglecting local business.

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THE American plan of regulating railroad time, which has been generally adopted for local time also in this country, is making considerable progress in Europe. In August last the German Railroad Union, at Dresden, voted that, beginning with the time-table changes next spring, uniform time shall be adopted for all the railroads in the Union. The time or hour adopted is the hour of the 15th degree east of the meridian of Greenwich, and this will regulate time on all the roads, regardless of the local changes. As the Union includes all the railroads of Germany and Austria-Hungary, this is a very important step toward the introduction of the system in Europe.

At the same time the Union expressed the opinion that railroad time, as thus established, should be adopted as the general time for all local and civil purposes in the country served by the roads, and it is stated that the Government is preparing a bill for submission to the Reichstag which will carry this recommendation into effect.

Belgium and Holland will shortly adopt the same system, and it has many advocates in France, so that the probabilities are that Europe will before long be governed as to time by this system, which is now so thoroughly established here that no one, we believe, desires to go back to the old plan. In time the consent of all civilized nations will be secured, and the world will be divided into hour zones, the change of an hour at each 15 degrees being recognized everywhere.

It is proposed to cross the Potomac from Washington to Arlington Heights by a suspension bridge, having a clear height of 105 ft. above the water, with a river span of 1,100 ft. and two shore spans of 652 ft. each. Plans for this bridge have been prepared by the Corps of Engineers, and they provide for approaches at each end composed of masonry arches and earth embankments. The towers for the bridge will be of granite about 210 ft. high, and will in general type resemble the towers of the Brooklyn Bridge. A new bridge is very much needed at that point, and the suspension bridge, as proposed, would not at all interfere with the navigation of the river.

A test of English and American locomotives is to be made on the New South Wales Government railroads, where there are a number of engines from the Baldwin Works. The dimensions of the classes of engines chiefly used in freight and general service are:

| | Baldwin Consolidation. | Baldwin 10-wheelers. | Beyer, Peacock & Co., 10-wheelers. |
|---|---|---|---|
| Cylinders | 21 × 26 in. | 21 × 24 in. | 20 × 26 in. |
| Drivers, diameter | 51 in. | 61 in. | 60 in. |
| Adhesion weight | 120,000 lbs. | 97,000 lbs. | 94,000 lbs. |
| Total weight | 132,000 " | 130,000 " | 128,000 " |
| Heating surface | 2,000 sq. ft. | 1,935 sq. ft. | 2,000 sq. ft. |
| Grate area | 28 " " | 28 " " | 28 " " |
| Boiler pressure | 160 lbs. | 160 lbs. | 160 lbs. |

All the engines have copper fire-boxes and brass tubes. The road on which they work has grades of 130 ft. and 176 ft. per mile, and 11° curves.

The special competitive trial will be made with the ten-wheeled engines. There are 12 from the Baldwin Works, and 50 from Beyer, Peacock & Company, and they will be run together on similar work, and an effort made to have a fair trial on their merits. They are to be tested as to capacity, economy in fuel, and cost of repairs, and the results will be observed with much interest.

## COMPOUND LOCOMOTIVES.

In a review of a report of the performance of a compound and a simple engine on the Brooklyn Elevated Railroad, published in the January number of the Journal, attention was called to what appeared to be incongruous facts in relation thereto. The most noteworthy of these was the performance of the two boilers, the report showing that, with substantially the same trains, the boiler of the compound engine evaporated an average of 8.25 lbs. of water per lb. of coal, whereas the boiler of the simple engine evaporated only 6.69 lbs. In the *National Car and Locomotive Builder* of February, the editor of that publication, as an explanation of this apparent anomaly, says: " There is no question that an important part of the saving effected by a compound over a simple locomotive results from the increased efficiency of the boiler of the former engine."

Probably a good many readers will feel disposed to place an interrogation mark after this assertion, or they will ask that a definite value be assigned to the word " important." Does it mean that 1 per cent., or 25 per cent., of saving is due to this cause, and where is the proof that such a saving, whatever it may be, is due to the cause assigned?

The explanation given for the saving due to the cause quoted is that " the decreased volume of steam called for by the cylinder of the compound locomotive in performing the work done by the simple engine increases the efficiency of the boiler and has an effect equivalent to enlarging its capacity, since the drain of steam is reduced." Stated as a general principle, this is admitted, but if quantitative values are assigned to the volume of steam and to the efficiency of the boiler, it might be disputed. Thus, the report before us shows that the gain of the compound engine in water consumption was 23.8 per cent. In other words, the compound engine used 23.8 per cent. less water in doing the same work than the simple engine did. It must be kept in mind, though, that the simple engine had a pressure of only 140 lbs., whereas the compound carried 155 lbs. Had the steam pressure in each engine been equal, undoubtedly the difference in water consumption would have been less.

When we compare the rate of evaporation of water per pound of coal, it is seen that, in the compound boiler, 23.3 per cent. more water was converted into steam by each pound of coal than in the boiler of the simple engine. This is attributed by our contemporary, as explained above, to the fact that the boiler of the compound engine was not worked as hard as that of the simple engine, to the softened exhaust of the compound, and to the fact that the exhaust steam escapes up the chimney of the compound in two puffs to each revolution of the wheels instead of four, as in the simple engine. The writer says: " From the experience we have had with locomotives with large and small wheels and all other parts the same, we are inclined to think that, under certain limits, slow exhausts tend to increase the efficiency of the boiler." There are persons whose experience leads them to think just the reverse of this, and who believe that an engine with small wheels and cylinders proportioned to them will make more steam, and do it more economically, than one with large wheels and cylinders—in other words, that many small puffs of steam are better than a few big ones.

The whole argument for the compound locomotive depends upon whether it will do a given amount of work with materially less steam than a simple one will. If, in that respect, there is sufficient saving to compensate for the additional cost and complication of a compound locomotive, the case is proved in favor of the latter; but what may be called the consequential advantages of a light exhaust and few puffs of steam—if they are advantages—are available on simple engines as well as on compounds.

A skillful writer has so many ways of stating the results of locomotive experiments, he would probably show an economy of fuel as a result of painting the chimney sky blue, if he was interested in producing such a result. Now, no misrepresentation in the report here criticised is charged or intimated. We have no doubt of the fact that the performances of the engines was precisely as reported, but we do not agree with our contemporary that it is a matter of secondary importance " how the thing comes about." It is of the utmost importance to know whether the " thing" is a consequence of the compound system or of some other cause. The experiments seem to have been conducted with great care, but the trial has been made *ex parte*, as the lawyers say. The simple engine had no counsel or advocate, and all of us know the readiness of mind with which we accept evidence favorable to our interests, and the critical spirit that is aroused by that which is unfavorable. Before the results of such experiments as we are criticising can be accepted implicitly, the simple

engine should have an advocate and a friend as well as the compound. It, at any rate, should have the advantage of equal steam pressure, be the advantage much or little. If a compound locomotive consumes less steam than a simple one, and therefore, the demands made on the boiler are less in the former than the latter, and, as a consequence, more water can be evaporated per pound of coal in the one than in the other, it is fair to attribute that advantage to the compound system, although it might still be an open question whether it would not be more economical to put the extra weight of the compound cylinders and other parts into the boiler of the simple engine, and thus enlarge it. A softened exhaust would then be available, and if two puffs per revolution are better than four—of which there is no evidence, excepting that our critic is "inclined to think so"—why, then we could arrange the engine to puff twice instead of four times to each revolution.

What is needed is a series of competitive tests of compound and non-compound locomotives—conducted in a similar manner to the Burlington brake tests of a few years ago—in which slow and fast, heavy and light trains, should be hauled under all the various conditions of actual practice.

If compound locomotives will save 37.7 per cent. of the fuel consumed, it is a matter of the most momentous importance to railroads and to the whole country, and the RAILROAD AND ENGINEERING JOURNAL will be the last to interpose any obstacles in the way of that fact being demonstrated; but when our esteemed contemporary asks us to accept the conclusions of an *ex parte* report as "irrefragable facts," and hold our tongues, we will "keep on exclaiming," and ask for more proof and, if need be, like a Scotch jury, bring in a verdict of "not proven."

## PASSENGER RATES IN EUROPE.

FROM a report recently prepared by order of the French Chamber of Deputies, it appears that the average rates of fare in different European countries are as follows, in cents per mile:

| COUNTRIES. | First-class. | Second-class. | Third-class. | Fourth-class. |
|---|---|---|---|---|
| France | 4.0 | 3.0 | 2.2 | ..... |
| England | 4.1 | 3.1 | 2.0 | ...... |
| Belgium | 3.1 | 2.4 | 1.6 | ...... |
| Holland | 3.4 | 2.7 | 1.7 | ..... |
| Germany | 3.2 | 2.4 | 1.6 | 0.8 |
| Hungary | 2.4 | 1.6 | 0.8 | ...... |
| Switzerland | 3.4 | 2.4 | 1.7 | ..... |
| Italy | 3.6 | 2.5 | 1.6 | ...... |
| Spain | 4.2 | 3.2 | 2.0 | ...... |
| Russia | 4.8 | 3.5 | 1.8 | ...... |

There is a considerable difference in the accommodations afforded the lower classes of passengers in different countries. In England, for instance, second and third-class coaches are carried on nearly all the express trains, while in France and Germany third-class cars are found only on accommodation trains, and on the faster express trains only first-class passengers are taken. The only country having a fourth class is Germany, and the cars of that class are usually attached to freight trains.

Hungary has the lowest rates, probably owing to the zone-tariff system which has been applied in that country with considerable success. Low rates are found in Belgium, Holland, Germany, and Switzerland, all countries where incomes are limited and expenses carefully cut down. Russia, a country where travel is comparatively light, has the highest rates. England and France come next, but they are the two countries which provide the best accommodations for passengers.

As compared with our own country, Belgium, Holland and Germany come nearest to it, their second-class rate being nearly the same as our *average* passenger receipt, while their first-class is not widely different from our regular rate, with sleeping or parlor car charges added. It is not very easy to make a comparison, however, as the rates in different sections of this country differ so much.

The information was collected with a view of assisting the French Chamber in preparing a measure for the regulation and equalization of passenger rates. This proposed law is now under consideration.

## HIGHWAY ROADS.

THE Massachusetts Institute of Technology in Boston is to have a course of instruction in Highway Engineering, for which the necessary funds have been provided by Colonel Albert M. Pope, of Boston, a gentleman who has taken an active and intelligent interest in highway improvement. It is hoped that this course will attract a number of students and will be the means eventually of disseminating information as to proper methods of building and maintaining highways.

The short course offered by Vanderbilt University, in Nashville, Tenn., for the instruction of local road officers, has, we believe, met with some success, and has attracted quite a number of the persons for whose benefit it was intended. Such instruction is very much needed, and cannot fail to be beneficial.

The cause of highway reform is making some progress in various quarters of the country. In several counties in New Jersey the adoption of the county road law, which was passed by the Legislature some time ago, has been the means of beginning measures which, it is hoped, will result in permanent and substantial improvement of the highways.

In New York no action was taken on Governor Hill's excellent suggestions by the last Legislature, but it is hoped that something will be done this year, whether by adopting the proposal to build State roads, or by providing for some form of general supervision for the highways. The present condition of the roads in many parts of New York is a disgrace to so wealthy and prosperous a State, and some measure of reform is urgently needed. It is said that the Governor will again call legislative attention to the subject, and will urge it very strongly. The New York State Road Improvement Association, which was organized last year, has been doing something in awakening public interest in the question, chiefly through the efforts of its President.

In Pennsylvania the Commission appointed by the Legislature to consider this subject has prepared a draft for a new law, which will be submitted for action this winter, and which makes as radical changes as were considered at present advisable. The plan in substance provides for the election by the people of three road commissioners for each township, who will appoint the roadmasters of the various districts, the latter receiving pay. The Commission do not feel warranted in recommending at present

the abolition of the system of working out road taxes, but have made the provisions of the law as stringent as possible. Property owners who desire to work out the tax will be required to notify the town commissioner in the spring, and will be required to do their work just when and where they may be directed by the roadmasters; and in case they fail to appear at the appointed time and place, a substitute will be promptly hired, and the delinquent will be obliged to pay the tax. This is intended to obviate the great defect of the present system, under which whatever work is done upon the roads is done when the farmers have most spare time, which is precisely the period when it does the least good.

The defects of this bill are chiefly that it is not radical enough; the system of working out road taxes should be abolished altogether, and more responsible commissioners could probaby be obtained, if a county instead of a township were made the field of their operations. The Commission, however, has probably showed wisdom in advancing slowly, and not trying to do too much at once.

The proposed law provides also a system of what may be called "premiums." For every mile of improved road having a permanent stone or gravel foundation built by the township and approved by the County Commissioners, the county will build an additional mile and the State another, so that any township can secure three miles of new road at the cost of one. This proposition is likely to meet with considerable question in the Legislature, and, in fact, the whole law as presented by the Commission may be considerably modified before passing, should it pass at all.

In some of the Western States also movements in favor of better roads are reported. Public attention is slowly being drawn to the question all over the country, in fact, and in the course of a few years some substantial improvement may be looked for.

## BUILDING THE NEW NAVY.

BUREAU OF CONSTRUCTION AND REPAIR. *Annual Report to the Secretary of the Navy for the Fiscal Year ending June* 30, 1890. Chief Constructor T. D. Wilson, Chief of Bureau.

The building of the new Navy has thrown upon the Bureau of Construction more work during the past two or three years than has fallen to its share at any previous time since the war. The designs of all the new vessels have had to be prepared, the drawings made and furnished to contractors, and a great variety of similar work to be attended to, so that the officers have been very fully employed.

The annual report of Chief Constructor Wilson is a very interesting record of the progress made in naval work during the past year, and also of the present condition of the Navy. That the new ships were not begun too soon is shown by the following extract:

With the gradual appearance of the new steel navy has come the rapid retirement of the wooden fleet.

When the *Chicago*, *Boston*, *Atlanta* and *Dolphhin* were begun, the serviceable wooden vessels numbered 37 in all; now there are 11 new steel vessels and one first-class torpedo-boat in commission, and only 18 wooden steam vessels.

In about seven years the wooden fleet will have practically disappeared, or have been utilized as receiving and training vessels.

The report is illustrated by a number of drawings of the new ships designed by the Bureau, and by photographs showing the progress made on the vessels under construction. The more important of those designed and begun during the year were Cruiser No. 6, as yet unnamed; Armored Cruiser No. 2, the *New York*; the great three-screw cruiser, at present designated as No. 12, and the three battle-ships, the first of their class for our Navy. All of these ships were designed by the Bureau of Construction, and all of them are described and illustrated in the report.

## NEW PUBLICATIONS.

THE THEORY AND PRACTICE OF SURVEYING. *Designed for the use of Surveyors and Engineers generally, but especially for the use of Students in Engineering*; by Professor J. B. Johnson, C.E. (John Wiley & Sons, New York. Price, $4.)

Professor Johnson's work has become so well and widely known since its first appearance, some five years ago, as the standard treatise on surveying, that it is hardly necessary to enter into an extended review here. It is enough to say that it is the most complete and thorough book on the subject, and that it was the first to treat fully, in an elementary way, several important branches, such as City Surveying, Hydrographic Surveys, and Geodetic work. That the present is the seventh edition is fair evidence of its importance.

In this edition some important changes and additions have been made. Part I., on Instruments, has been enlarged by descriptions and cuts of several new instruments, including the architects' level, Wood's double sextant, and the cross-section polar protractor used in the tunnel of the new Croton Aqueduct. Some of the tables have been replaced by later ones worked out by the Coast Survey. The chapter on Land Surveying has been entirely recast, and considerable new matter added. The description of the United States Land Surveys has been rewritten and enlarged. Some new tables have been added, and a method of running out parallels of latitude is also an addition. These changes are the result of experience, which has showed the weaker points of the original work, enabling the author to strengthen them, and to supply what may have seemed to be deficient.

The book is well printed, in type of good size, and the tables especially deserve praise from the fact that they are printed with fair-sized figures and are not as crowded as such work is apt to be. An exception must be made in the case of the tables of natural sines and tangents (VI. and VII.), which would be less trying to the eyes had more space been allowed them. The illustrations are fair; some of them are good, but a few are hardly up to the standard which so excellent a book seems to require.

The defects are not serious, however, and the book is one which would seem to be indispensable for the student, and almost equally valuable to the engineer and surveyor in active practice.

A MANUAL OF LAND SURVEYING: *Comprising an Elementary Course of Practice with Instruments, and a Treatise upon the Survey of Public and Private Lands.* By F. Hodgman, C.E., and C. F. R. Bellows, C.E. (F. Hodgman, Climax, Mich. Pp. 480; price, $2.50.)

This book had its origin in the action of the Michigan Association of Surveyors & Civil Engineers, which referred to a committee the task of preparing a manual which should give authoritative answers to the many perplexing question constantly arising in a surveyor's practice. To this end, the many decisions of the courts in relation to surveys were carefully collected and digested, so as to give as fully as possible all the points in relation to surveys and boundaries which are likely to arise in ordinary work. This has not been done at the expense of the mathematical part of the work, and the latter has been given at sufficient length to make it serve as a text-book for the student, or as a companion for the surveyor.

The book, as first issued, has stood the test of time, and the fifth edition is now issued, revised by Mr. Hodgman, and with some additions.

The various chapters treat of Instruments; Measurements; Platting and Computing Areas; Curvilinear Surveying; Original Surveys, including those of the public lands; Subdivision of Sections; Resurveys; Relocating Lost Corners; Map-making and Leveling. A supplement contains the usual tables.

It is a thoroughly practical book, and must be appreciated by the land surveyor, who so often needs a guide which will give him in condensed and intelligible form the law of the cases which he is constantly meeting, by which his action must be governed. Much often depends on his action, and it is important that it should be correctly taken in all respects.

EXAMINATION OF WATER FOR SANITARY AND TECHNICAL PURPOSES. By Henry Leffman, M.D., Ph.D., and William Beam, M.A. (P. Blakiston, Son & Company, Philadelphia. Price, $1.)

The examination of water and the decision as to the best sources from which it is to be obtained are questions which often meet the engineer in practice, and which he cannot always obtain the aid of the chemist to decide. Very often also points of considerable importance may be affected by the water supply, such as the location of water tanks on a railroad, the choice of a place for a division station and shops, and the like. The aid of the chemist should, of course, be called in wherever possible; but it is well for the engineer to know something of the best methods to be adopted in examining water, and of the qualities which make it available or otherwise for his purposes.

Something may be judged of the scope and plan of this book by the titles of its chapters. They are on History of Natural Waters; Analytical Operations; Interpretation of Results; Biological Examinations; Purification of Drinking Water; Identification of Source of Water; Technical Applications; Analytical Data. The chapter on Technical Applications includes the definition of the qualities which affect water to be used in boilers and the methods adopted for purifying water for this purpose when necessary.

The engineer engaged on water works will find of especial interest the sections on sanitary applications, on biological examinations, and on the latest methods adopted for purifying drinking water. The practical applications are numerous, and will readily suggest themselves.

Especially valuable is the section on interpretation of results, for, as experience has often shown, it is easier to make a test, in many cases, than to use properly the lessons which the test should teach.

PRELIMINARY SURVEY AND ESTIMATES. By Theodore Graham Gribble, C.E. (Longmans, Green & Company, London and New York. Illustrated, 420 pages; price, $2.25.)

An English technical book which is, confessedly, based to a considerable extent on American methods, is somewhat of a rarity, but it is found in this case. The author has apparently seen practical service in Canada and Australia, and he criticises English methods of instruction in his preface even more severely than an American would be apt to do. The young English engineer, he thinks, is not, as a rule, sufficiently trained in practical methods; his ideas have not sufficient flexibility, and he is too much inclined to look with disfavor on everything which differs from English work. The consequence is that in new countries, even in the English colonies, the door is closed to the English engineer as soon as men can be trained abroad. This tendency he wishes to change. Something of the general plan of his book may be learned from the following extracts from his preface:

In simplicity of survey practice, uniformity of gauge, types of bridges, and rolling stock, the American engineer may be profitably (though not slavishly) imitated in the work of opening out a new sphere of enterprise . . . . .

The methods of surveying considered in the following pages are by no means exclusively American. In the class of work formerly called telemetry, but now tacheometry, we have to go to Italians, French and Germans for most of the original conceptions, and the best modern developments. Comparatively few English engineers really practise these methods unless they have learned them abroad, although some are thoroughly proficient in them.

The title of this book, "Preliminary Survey," is American, and answers somewhat to our "Parliamentary Work;" but it covers a wider range—in fact, the whole science of surveying in a condensed form, with the exception of those minute details where very great accuracy is required. . . . . .

Considerable use has been made of standard authorities on both sides of the Atlantic, but the subject-matter is in the main the result of actual experience. The necessary compactness of such a work has made it eclectic. Some methods have been passed over with slender comments, although occupying much space in other text-books. On the other hand, such subjects as tacheometry, computation by diagram and slide-rule, signaling, etc., which are as yet hardly known to the general public, except in pamphlet form, are here treated of at considerable length.

On these lines Mr. Gribble has produced a book which is worth study. The criticisms of a friend should be profitable, and it is well to know how our own methods appear to one who has been trained in others. Much is also to be learned by combining different systems, and a wise eclecticism is, perhaps, the best of all methods.

The chief subjects treated of, after the general introduction, are Reconnoissances; Hydrography and Hydraulics; Geodetic Astronomy; Tacheometry; Chain Surveying; Curve Ranging; Graphic Calculation for Preliminary Estimates; Instruments. An appendix contains tables for curves and spirals.

Perhaps the chapters on Reconnoissance and on Tacheometry are the most interesting; but there is much to be found that may be carefully read, and the book will repay attention given to it by engineers, even if they do not always agree with the author.

A STUDY OF COMBUSTION. By C. Chomienne, Engineer of the Couzon Forge. (Imprimerie Chaix, Paris.)

This is a reprint of a paper prepared by M. Chomienne, with some of whose work our readers are familiar, for the Society of Alumni of the French National Schools of Arts and Trades. That is is a thorough and carefully executed piece of work need hardly be said, when speaking of the author. His object has been to consider the subject of Combustion in the light of the latest experience and the latest experiments. Especial weight is given to the latest forms of fire-boxes, and to devices for ensuring complete combustion of fuel; to tubulous and other types of boilers for high-pressure; and to the use of liquid and gaseous fuels. Some prominence is also given to the necessity—more felt at present in France than in this country—of the closest economy in the consumption of fuel, and the complete utilization of the heat produced by its combustion in the boiler, a point to which too much attention can hardly be given.

NEW ENGLAND ROADMASTERS' ASSOCIATION: *Proceedings of the Eighth Annual Convention, held in Boston, August* 20 *and* 21, 1890. (The Association, Northampton, Mass.)

This report contains much matter of interest to engineers and roadmasters, including reports and discussions on Maintenance of Track, Inspection of Road-bed, Frogs and Switches, and Ties. The members evidently have among them many active and observant men, whose notes of experience are of value and interest, and who are not afraid to bring them out before the convention.

The progress made by the Association is shown by a glance at this report and the *Proceedings* for the previous year. Size alone is not always a test of a book, but in this case the report has almost doubled in size without any diminution in excellence. The Association is to be congratulated on the evidence thus presented of growing activity and usefulness.

MASTER MECHANICS' ASSOCIATION: GENERAL INDEX TO THE ANNUAL REPORTS. *Covering the Reports from the First to the Twenty-third, Inclusive*—1868–90. Prepared by Angus Sinclair, Secretary. (The Association, New York.)

The preparation of this Index was undertaken by Secretary Sinclair in accordance with a resolution passed by the Association last year. It is hardly necessary to say that it will be of great service to those members and others who preserve their reports and have occasion to refer to them. An editor especially appreciates the time and labor spent in searching for a report or paper through a series of volumes; and he also appreciates thoroughly the care with which Mr. Sinclair's work has been performed, and the time and trouble required for such a task.

## TRADE CATALOGUES.

*Central Station Electric Lighting Plants and Electric Railroads of the United States. The Thomson-Houston Electric Company, Boston.*

This book consists of a series of outline maps of the United States, showing the cities where electric lighting plants are in operation, the marks on the map indicating what system is in use in each place. A second series, on a somewhat smaller scale, shows the cities which are provided with electric railroads, the system in use being also indicated on these maps. These maps are accompanied by some pages of tables, giving the number of central-station lighting plants of different systems, and also the number of electric railroads in operation.

The map is very convenient for use by those who are interested in electrical matters. The maps are interspersed with advertising pages, which are chiefly taken up by manufacturers of electrical apparatus, and of steam-engines and other auxiliary machinery.

*Staunton, Virginia: its Past, Present, and Future. The Staunton Development Company.*

This book is intended to make known to the world the advantages and prospects of the town of Staunton and the adjacent country. This is done by a well-written historical sketch and a general description. The best part of the book, however, is the illustration, which includes a number of views in and about the town and in the adjoining country. Most of these are from photographs, and they include some of the best work of the kind we have ever seen. They certainly give the reader an excellent idea of the place, and are a most attractive advertisement.

*Illustrated Catalogue of the Decauville Portable Railroad. Petit-Bourg, France; La Société Decauville Ainé.*

*Van Vranken's Automatic Flush Tank for Flushing Sewers, Drains, etc. Schenectady, N. Y.; Benjamin Van Vranken.*

## BOOKS RECEIVED.

*Reports of the Consuls of the United States to the State Department: No.* 122, *November*, 1890. Washington; Government Printing Office.

*European Emigration: Studies in Europe: by F. L. Dingley, Special Consular Report to the State Department.* Washington; Government Printing Office.

*Compound Locomotives: by Professor Arthur T. Woods, M.E.* New York; R. M. Van Arsdale (price, $2). This book is received too late to give it the comment which it deserves, in the present issue.

*Annual Report of the Postmaster-General of the United States for the Fiscal Year Ending June* 30, 1890. Washington; Government Printing Office.

*Cornell University, College of Agriculture: Bulletin of the Agricultural Experiment Station, No. XXV, December,* 1890. Ithaca, N. Y.; published by the University.

*Proposed Tennessee Highway Law.* Nashville, Tenn.; the Nashville Commercial Club. This is a draft of a very excellent act prepared by a committee of the Nashville Commercial Club, and submitted to the Tennessee Legislature.

*Eighteenth Annual Report of the Commissioner of Railroads, State of Michigan, for the Year* 1890: *John T. Rich, Commissioner.* Lansing, Mich.; State Printers.

*Facts and Figures about Norfolk, Va.* Compiled and issued by the Chamber of Commerce.

*Report of Committee on Roads and Draft of Proposed Road Law.* Pittsburgh, Pa.; the Western Society of Engineers.

*American Shipbuilding and Lake Transportation: by Joseph Oldham, C.E., Naval Architect.* Cleveland, O. This is a comparison between the design, construction and general efficiency of the freight steamers used on the great lakes and foreign cargo steamers.

*Eighth Annual Report of the Board of Railroad Commissioners of Kansas, for the year ending December* 1, 1890: *James Humphrey, George T. Anthony, Albert R. Greene, Commissioners.* Topeka, Kan.; State Printers.

## ABOUT BOOKS AND PERIODICALS.

IN the POPULAR SCIENCE MONTHLY for February, Mr. Durfee's articles on the Developments of the Iron Indrustry in America are continued by a paper on Iron Smelting by Modern Methods, which, like the previous articles, is very fully illustrated. Another illustrated article is on Progress in Agricultural Science; and Mr. Charles Morris has an interesting paper on the Storage of Cold. The Editor makes a strong appeal in favor of the International Copyright Bill.

The military article in OUTING for February gives a description of the Active Militia of Canada. The Racing Canoe and its development are discussed by Mr. Vaux, and the articles on Photography are continued.

The third of Sir Edward Arnold's articles on Japan appears in SCRIBNER'S MAGAZINE for February. These articles will be concluded in the March number of this Magazine, and in that number also will be an account of the National Geographic Society's Explorations of Mount St. Elias, made last summer. The Practical Means of Ornamenting Ponds and Lakes will be discussed by Samuel Parsons, Jr., Superintendent of the New York Parks.

The STEVENS INDICATOR for January includes articles on Cable Traction on Elevated Railroads, by Charles W. Thomas; Marine Governors, by J. Hansen; Measurement of High Temperature, by W. A. Ebsen and E. W. Frazar, with several other articles of interest, including the Use of Electricity in operating cranes and machine tools, and a note on the performance of the double-screw ferry-boat *Bergen*.

In the ARENA for February, M. Camille Flammarion, one of the most eminent of European astronomers, writes on New Discoveries on Mars, the paper being accompanied by a full-page map of that star, and smaller maps showing recent apparent changes on its surface. Mr. C. Wood Davis discusses the Farmer, the Investor and the Railroad, studying the railroad problem from a point of view which is rather that of the farmer than of the railroad owner or manager, but presenting some facts and arguments which deserve consideration.

Among the books now in preparation by John Wiley & Sons is CONSTRUCTIVE STEAM ENGINEERING, by Professor Whitham, whose book on Steam Engine Design was published not long ago by the same firm. The object of this book is to treat the constructive features exhaustively, not discussing design, but presenting the constructive details, the various forms of valve gear, and the different types of engines and boilers in use.

In HARPER'S MAGAZINE for February the descriptive articles include one on Finland, a country whose geography, history and people are but little known in this country, but present some very interesting points. Mr. Child's South American articles for this month takes in the Straits of Magellan, including a sketch of the coast from Peru southwest to the Straits on the Atlantic side from the Straits northward to Montevideo. In the Heart of the Desert, Mr. Warner gives an account of a visit to the Pueblos of New Mexico, and the Grand Cañon of the Colorado. All these articles, as well as a number of lighter articles in the number, are profusely illustrated.

In BELFORD'S MAGAZINE for February there is the usual variety of lighter reading, with some more solid matter. This magazine is, as usual, plain and outspoken in its editorial opinions, and no one of its readers need be in doubt as to where it stands on any question of current importance.

## ENGLISH LOCOMOTIVE PERFORMANCE.

*To the Editor of the Railroad and Engineering Journal:*

I NOTICE that you quote the London *Engineer* as stating that the maximum coal consumption of an English engine is 75 lbs. per square foot of grate surface per hour. There is some mistake about this figure, for 100 lbs. is reached in daily working of both freight and passenger trains. Taking an English freight train running full speed, say 35 miles per hour, on a fairly level road, the consumption of coal will be from 45 to 50 lbs. per mile or averaging say 1,700 lbs. per hour. As the grate area in English engines is rarely over 18 sq. ft. in passenger express engines, or 17 sq. ft. in freight engines, this gives about 100 lbs. as a very usual performance in daily work, often for over one hour at a time.

An express engine running over a similar road at 55 to 58 miles an hour will burn from 27 to 35 lbs. per mile, giving say 1,000 lbs. per hour, which is 100 lbs. per hour per square foot of a grate of 18 sq. ft. area.

I notice the *Engineer* in a recent issue quotes the results of some experiments made by me 13 years ago on the North British Railway when I was Assistant to the then Locomotive Superintendent, Mr. D. Drummond. While I took every care that the results should be accurate, they cannot be said to represent the average performance of an English good engine. The experiments were made for the special purpose of testing the relative economy of pumps *versus* injectors, the water being heated by the exhaust steam where the pumps were used. As the engines in other respects were precisely similar, the results obtained were fair comparisons between pumps and injectors, but for the following reasons did not represent what these and other English engines are capable of in actual practice.

The engines were of a pattern new on that line, and the firemen were much puzzled by the great slope of the grate and the peculiar position of the ash-pan damper. They consequently had difficulty in keeping steam, and at the time the experiments were made the blast-pipe nozzle was unduly contracted, thus creating an increased back pressure and somewhat cutting and wasting the fire. Some months afterward, when the men understood the engines, they did far better, steamed admirably, burned less fuel and hauled heavier loads.

It will be seen that under these circumstances the experiments hardly represent average performances, which I am satisfied in general practice give fully $8\frac{1}{2}$ lbs. of water per pound of coal, while over 9 lbs. is often attained by good firing.

I dare say it will be a matter of surprise that these engines only exerted a tractive force equal to about one-seventh or one-eighth of their adhesion weight. The Scotch climate, however, is damp and misty, and as a matter of fact, we never ascended one grade of 53 ft. per mile near the border between England and Scotland without some slipping, though the steeper grades (75 ft.) were often surmounted without a slip.

The proportion of adhesion to tractive power differs largely with climate, and I may mention that here I have found that the maximum tractive power the engine is ever capable of exerting (the average pressure in cylinders being 85 per cent. of the boiler pressure) should be not more than one-quarter of the weight on the drivers. We have some engines in which it is $\frac{1}{3.77}$ and they slip so badly that they are being altered, the cylinders being reduced 1 in. in diameter. This slight change cures the slipping, showing that the coefficient of adhesion is more sensitive and more exact, in this climate at any rate, than many suppose.

I may add that the loads taken represent with tolerable accuracy the average loads in actual practice on British lines. They are, of course, very light as compared with those in American practice, but it is well known that this is due to a variety of causes, the chief being the higher speed at which freight trains are run in order to meet competition and keep out of the way of the numerous fast passenger trains.

I have been tempted to write these lines thinking possibly that you may have founded some arguments on premises which need a little explanation and qualification.

D. H. NEALE,
*Mechanical Engineer, New South Wales Railways.*

## ARGENTINE RAILROADS.

THE total mileage of railroads in operation in the Argentine Republic at the close of 1890 was 5,747 miles, an increase of 732 miles over the length in operation at the close of 1889. In addition to this mileage there were at the close of year the 1,170 miles under construction, and so nearly completed that they will probably be in operation during the present year. These railroads represent a capital of $260,000,000 gold value. About 320 miles of road belong to the National Government and 170 miles to different provincial Governments; the National Government, moreover, guarantees the interest on the bonds and stock of Pacific, the Argentine Great Western, the Eastern and the Central Northern Companies. The increase in mileage for several years past has been very rapid, and railroads have been pushed out in all directions, the most important line perhaps being the Pacific road, the extension of which is now under construction over the Andes to connect with the Chilian system.

At the close of 1890 there were in use on these railroads 436 locomotives, 280 baggage and 500 passenger cars, and 10,525 freight cars. There was a considerable increase in equipment in the course of the year, most of it being imported from Europe, but in comparison with the length of road the rolling stock does not indicate a heavy traffic.

The roads at present are not by any means in a satisfactory condition, owing to the general business and financial collapse which recently occurred. In some parts of the Republic business is almost at a standstill, and the condition of the currency is so unsatisfactory that it is difficult for many of the companies to say what their returns really are. It is also true that in some directions the railroads have been built ahead of business, and while the growth of the country has been great and settlement rapid, it has not been sufficiently so to supply business for all the new lines. Moreover, some of the provinces have suffered from drought and locust, so that the crops have been very light, and the railroad outlook for the current year is not by any means a good one. If the financial affairs of the Government and of the several provinces can be arranged, there is little doubt that in course of time the growth of the country and the solid elements of prosperity which it contains will bring about a better condition of affairs, but for the present it must be considered that new railroad building is at an end, and little or nothing will be done in that direction for two or three years to come.

## THE CRUEIZE VIADUCT.

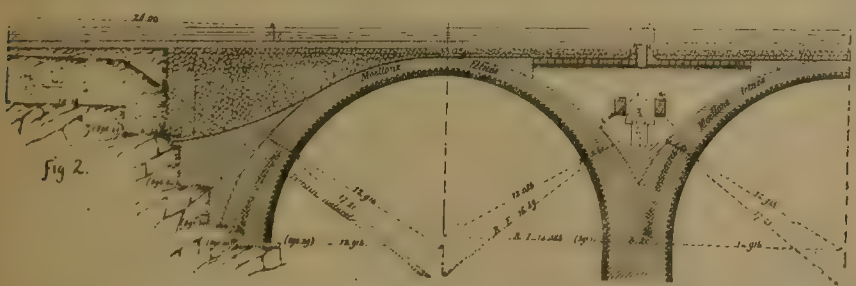
THE accompanying illustrations, from *Le Genie Civil*, show the viaduct which carries the Marvejois-Nessargues Branch of the Midland Railroad of France over the deep valley or ravine of the little river Crueize—a valley so deep, rocky and deserted that it is locally known as the Valley of Hell.

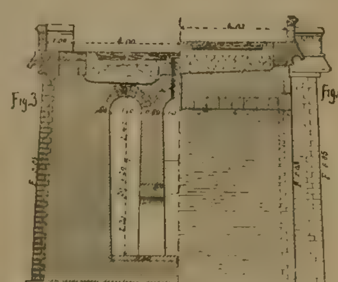
THE CRUEIZE VIADUCT.

The viaduct consists of six equal arches of masonry and is 218.8 meters (717.7 ft.) long; the height at the center, above the river bed, is 63.3 m. (207.6 ft.). It carries two tracks, which are at that point on a grade of 2.75 per cent., or 145.2 ft. to the mile.

The arches are 25 m. (82 ft.) span; in order that the springing of the two adjacent arches may be on a level, the radius of the lower half of each arch is 12.915 m. (42.4 ft.) and of the other half 12.085 m. (39.6 ft.). In the accompanying illustrations the first is a general view of the bridge; fig. 2 is a longitudinal section through two of the arches; fig. 3 is a half cross-section through a pier, and fig. 4 a half cross-section through the center of an arch.

The foundations presented no difficulty, as the rock is everywhere near the surface. The piers are of the buttressed form shown by the engraving. They are all 11.55 m. (37.9 ft.) extreme length, by 5.20 m. (16.1 ft.) extreme width, at the springing of the arch; their size at the foundation varies according to the height. The batter of the faces varies with each 5 m. (16.4 ft.) of the height, making the face of the pier practically a curve. This system has been adopted in a number of the larger French viaducts. The curve corresponds to the total pressure on the pier. The highest pier is 45 m. (147.6 ft.) from the foundation to the springing of the arch. The greatest depth to which it was found necessary to carry the foundations was 10 m. (32.8 ft.) below the surface; the average depth is 6.5 m. (21.3 ft.).




The construction of the road-bed is shown in figs. 2, 3 and 4. The ballast rests on broken stone filling, above the masonry.

The viaduct contains in all 894,645 cu. ft. of masonry, not including the foundations. Its total cost was $247,680, including clearing and foundation work. It is certainly a very symmetrical and handsome work in appearance.

## RAILROADS IN SIAM.

THE fact that the Government of Siam has advertised for proposals to build a railroad, and that some effort has been made to get bids from American contractors, will give interest to the following notes from our correspondent in Siam:

The line for which bids are asked is to run from Bangkok northward to Ayuthia, and thence northwest to Korat, a distance of about 167 miles. For about 47 miles the road runs through the low alluvial plains of the Menam, where embankment will be necessary to keep it above flood level; then for 37 miles over level plain country. The next section of 27 miles includes the ascent from this plain to a high table-land, nearly 1,000 ft. above sea level; the summit, as located, is 1,292 ft. above sea level. The remaining 56 miles to Korat is over nearly level table-land.

The gauge of the road is to be 4 ft. 8½ in. Bids, which are to be sent to K. Bethge, Director-General of Railroads at Bangkok, may be for a section or the whole line. The time allowed is from four to five years; the Government will furnish rails and equipment. The bridges will be of wood and the rails 56 lbs. to the yard. The approximate

estimates show about 4,860,000 cub. yds. earthwork; 260,000 cub. yds. rock-cutting; 6,600 cub. yds. retaining walls, and 66,000 cub. yds. bridge masonry.

The accompanying sketch map will give some idea of the line. The Menam is the great river of Siam and is navigable for large vessels. The Pra-sak is navigable for small rice-boats to Saraburi; the Muck-lek and the Lamba are in no sense navigable. The Lamba is a tributary of the Mekong, the great river of Cambodia. On the map at the point *A* is a secondary summit, and at *B* is the main summit; the rock-cutting and heavy jungle are between


the points marked *C* and *D*. The maximum grade is 1.5 per cent., to be equated for curvature; 15° curves are allowed.

The features which differentiate this work from ordinary railroad construction are:

1. Transport of machinery, tools, etc., 8,000 miles; this is by sea, as large vessels can land at Bangkok.

2. Extreme unhealthiness of the country, especially the district known as the "Fire God's Jungle," where all the heavy rock-work is.

3. Scarcity of labor, which is increased by superstition, by occasional interference of petty officials, and by the fact that the natives can get along with scarcely any money, and consequently do not feel the necessity of earning wages.

4. The surprising density of the jungle and the entire absence of roads for wheeled vehicles.

That work can be carried on in Siam is already proved, this Korat line having been surveyed and located at a cost of not much over $200 per mile, including preliminary work and office expenses.

Labor costs about a half-tical—say 25 cents—per day. The country people are generally honest, and when well treated and forced to take care of themselves, become quite satisfactory, at least so far as their *intentions* go. Working hours are generally from 6 A.M. to 2 or 3 P.M., with a half-hour interval. I have, however, habitually worked men longer than that without difficulty. Much risk would attend the importation of labor, owing to malarial fevers; possibly some Madrasee or Bengalee people might be proof against these, but the only strangers I have ever found able to stand the jungle air and water are Pegus and Tongsoos from Burmah. These men cost me about $15 per month each.

The Siamese Government has the character of paying surely, though somewhat slowly. The proposed railroad is a much greater financial flight than anything they have so far undertaken.

As to other enterprises, the Borapah Railroad Company is still asking for stock subscriptions, but without much success, as no railroad is likely to succeed in Siam except as a Government line or by foreign capital. The proposed line is from Bangkok east to the Bangpakhong River; it will run through an agricultural district, where the traffic is now served by canals of small dimensions, the boats being able to carry 10 or 12 tons only. The chief product of the country is rice.

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## THE DEVELOPMENT OF THE COMPOUND SYSTEM IN LOCOMOTIVES.

By M. A. Mallet.

(Paper read before the Société des Ingenieurs Civils, Paris; translated from the French by Frederick Hobart.)

(*Continued from page* 73.)

### STARTING APPARATUS.

The locomotives of the Bayonne-Biarritz Railroad have a starting valve placed on the left side of the smoke-box, the opening of which, determined by the action of the engine man on a screw or lever, permits the engine to work with direct admission to the small cylinder only, and exhaust from that to the large cylinder, or with direct admission to and exhaust from both cylinders; in the latter case the pressure on the piston in the large cylinder is reduced, in relation to the boiler pressure, either by throttling the steam or by an automatic reducing valve. This works very well, but two objections can be made to it, one that it is somewhat large and cumbrous in the heavy engines to which the compound principle is now applied; the other, that it requires considerable force to work it.

The form, but not the principle, of this valve was modified on some engines on the Southwest Russian Railroad, where M. de Borodine used a cylindrical valve or piston valve. The second objection was met by working the valve by a small steam cylinder, to start which requires only the turning of a small valve by the engineer.

In 1884 I presented a much more compact arrangement, which can be worked by the engine-driver, and without the exertion of any considerable force; this is shown in figs. 5 and 6, and consists of a chest or valve-box placed on the left side of the smoke-box. To this valve-chest are attached the exhaust-pipe of the high-pressure cylinder; the pipe leading to the low-pressure cylinder and forming an intermediate receiver, and the exhaust pipe leading from the small cylinder to the smoke-stack. In the valve-chest is a large valve which can close the passage from the small cylinder to the receiver when moved into the right position. On the same valve-rod is fixed a small valve balanced by a piston, and serving to open or to close the communication between the smaller cylinder and the exhaust, according to the position of the large valve.

This position is determined by the pressure existing in the intermediate reservoir.

If by the use of an auxiliary throttle valve placed on one side of the smoke-box, steam is admitted directly from the boiler into the reservoir at a pressure reduced either by a special valve or by throttling, this pressure closes the large valve and opens the exhaust valve, and the engine will then work as an ordinary engine. If we close the admission of live steam to the reservoir, the pressure will decrease and will cause a difference, which, combined with the pressure exercised upon the interior face of the large valve by the exhaust steam from the small cylinder, will open this large valve and close the small one, so that the working will be changed to that of a compound locomotive.

The change is determined by the working of what we have called the auxiliary regulator, which requires only the movement of a small lever by the engineer with a very slight exertion. In order to prevent a possible movement of the valves which would cause a loss of steam by direct exhaust to the chimney, and to make at the same time the change from simple to compound working more quickly, the auxiliary regulator is arranged in the manner shown in fig. 7. The valve *a* opens or closes, according to its position, the passage admitting live steam to the intermediate

reservoir. The nut securing this valve has a passage *n* opening outside, or in another position of the nut communicating with steam from the boiler. The tube *m* is carried back to the valve-box at a point in front of the balanced piston, as shown in fig. 6.

It follows from this arrangement that if, the apparatus being in the position shown in fig. 6, the valve is moved into the position shown in fig. 7, steam enters the intermediate reservoir and tends to close the large valve, while the space in front of the balanced piston being put in communication with the outside through the pipe *m*, the opening in the valve and the hole *n*, there is no resistance upon this piston. If, on the other hand, the engine is working directly, and the admission of live steam to the reservoir is then closed, there will be in front of the balanced piston a pressure of steam coming from the boiler which secures the opening of the large valve and the change to compound working. Moreover, as has been said above, this pressure prevents any movement of the valves while the engine is running.

This arrangement has worked in a very satisfactory way. It was applied on a number of large engines in France, in Switzerland and in Austria, and it was used on the six-wheel compound locomotive of the French State Railroads exhibited at Paris in 1889.

Fig. 5.

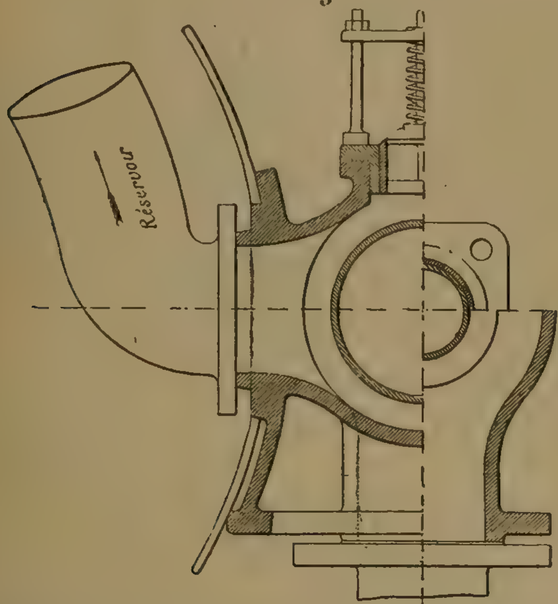
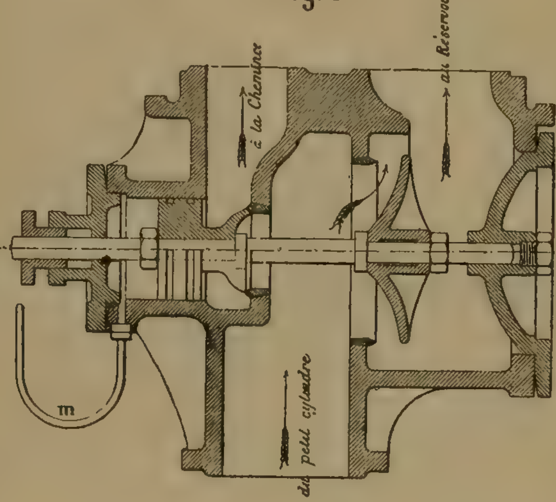



Fig. 6.



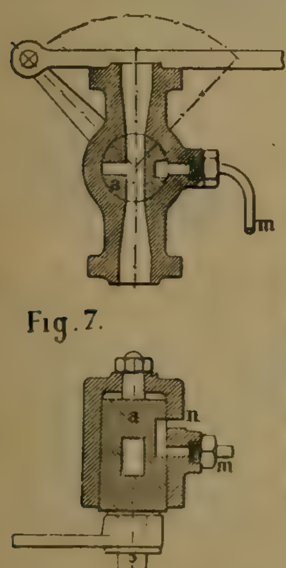
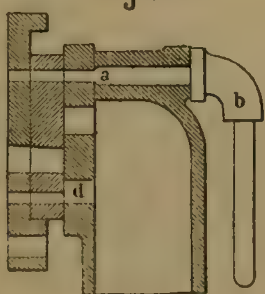




Fig. 7.

Fig. 8.

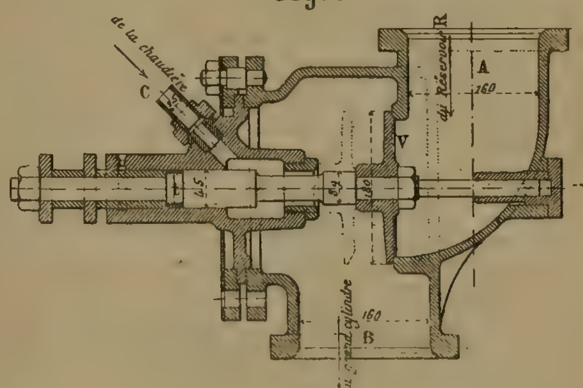



By this arrangement, the change from simple to compound working is made by the engineer, but it can, if desired, be made automatic. It is possible, at least in certain engines, to make the throttle valve in fig. 7 work by an arrangement similar to a speed regulator, in such a way that compound working would be immediately produced as soon as the speed of the engine passed a fixed minimum, and that, on the other hand, the engines when stopped would be always ready to start, with direct admission to both cylinders. This arrangement is applicable to tramway locomotives and to certain others which have to start with a full opening, such as yard engines.

The valve-chest which has been described carries on the side which is in communication with the intermediate reservoir a safety valve set at a certain point, the object of which is especially to prevent the consequence of the closing of the large valve by counterpressure while running. Instead of having the two valves upon the same rod, they can be arranged side by side with the rods joined by a lever, and this plan has been adopted in Russia.

In his first machines, M. Von Borries, to avoid altogether direct working even in starting, and seeking an excessive simplification, used a regulator shown in fig. 8. In this a small passage *a b* leads the live steam to an intermediate reservoir. The drawing represents the apparatus at the moment of starting, when the steam reaches at the same time both cylinders, the small one by the passage *d* and the large one by the passage *a*. If the throttle valve is opened further by raising it, the opening *a* is closed, while the passage of steam to the small cylinder is opened wider. In the lowest position of the valve, all the openings are closed.

Fig. 9.




If this apparatus showed itself sufficient for the small

locomotives for general service on which it was first applied, it is not the same for larger engines, and after several trials M. Von Borries adopted an arrangement which allowed him to start with full boiler pressure on the small piston instead of having only the difference between that pressure and the pressure in the intermediate reservoir. This arrangement consisted in the interposition at a point in the reservoir of a valve which prevents pressure of steam in the reservoir from reacting on the small piston. This arrangement is very much the same as my own, described above, and is, moreover, later, if we can judge by the dates of patents.

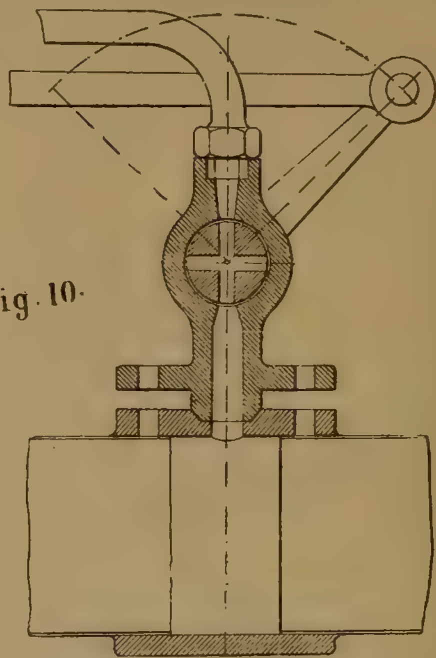
Fig. 9 represents an intercepting valve which permits the engines to act like mine in starting. In starting the engineer moves the rod which carries the valve *V* and brings that valve down upon its seat. Steam from the boiler is then introduced into the reservoir by the small pipe *c*; it acts upon the large piston, and cannot react upon the small one. When the machine starts the exhaust from the small cylinder causes the valve *V* to open as soon as the pressure behind it becomes greater than that in the reservoir; the admission of steam by the pipe *c* is then stopped. It will be seen that the time necessary for this pressure to open the valve depends upon the volume of the part of the intermediate reservoir in front of the valve, and it is placed as far as possible from the small cylinder. Nevertheless, as this reservoir can never be very large, the opening of the valve is produced at the end of one or two revolutions, which only permits working at full pressure during a very short time, while my own arrangement, as described above, permits the engineer to continue this period as long as he wished; until, for example, full speed is reached. Moreover, under certain circumstances, the reservoir would be filled and would render the starting more difficult, which would not happen with an arrangement not automatic.

M. Polonceau has described some modifications of this arrangement where a hinged valve replaces the intercepting valve. This is the system employed by M. Worsdell. Later, M. Lapage, I believe, changed the arrangement by doing away entirely with the lever, and it is the pressure of steam itself which closes the large valve and permits steam from the boiler to enter the intermediate reservoir until the pressure of the exhaust steam from the small cylinder becomes sufficient to open the large valve. This is called by M. Polonceau the "Von Borries valve." Mr. Urquhart uses on his passenger engines a system working like mine, but much more complicated; it requires the working of several levers to close some valves and open others.

The arrangement used on the compound locomotive from the Winthur Works, which was at the Exposition in 1889, is that of Von Borries, or rather of Lapage, with the addition of a small piston to aid in the pressure on the upper part of the intercepting valve and to keep closed the valve admitting live steam. The result is that in running with a low pressure, as in descending a grade, the valve will oscillate and permit steam to enter. To prevent this M. Von Borries has added in his later engines a stop which is worked from the engineer's cab by a rod. In my own arrangement the balanced piston does this work without any other complication.

The Von Borries valve has been for a long time the only one in use in Germany, while the Henschel and the Schichau valves have been used in only exceptional cases. Recently, however, M. Lindner, Engineer of the Saxon State Railroad, in order to avoid the difficulties which the use of a retaining valve presented, returned to the plan of a valve simply admitting steam from the boiler by an opening in the intermediate reservoir at the moment of starting; but in order to prevent the necessity of a separate movement by the engineer, this is arranged in a peculiar fashion. The valve has two passages placed at right angles in such a way that the passage is opened at the extreme positions and closed in any intermediate position. This valve is worked by a lever which is joined to the reversing lever or the reach-rod. The valve is opened when the reversing lever is at an extreme position corresponding to an admission of 80 per cent., and is closed when the lever is thrown back to the position corresponding to about 72 per cent. admission. Fig. 10 shows this arrangement, which is employed on some of the machines on the Saxon State Railroads. It may be curious to note here that this idea of admitting steam directly from the boiler into the large cylinders of the compound locomotive in starting, by

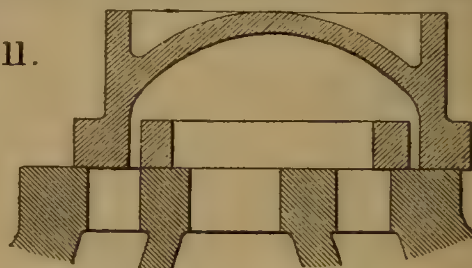
Fig. 10.



the extreme positions of the reversing lever, is clearly indicated in an English patent—that of Dawes, No. 1,857 of the year 1872—that is to say, at a time before the first applications of the principle of double expansion to locomotives.

To avoid reaction of the steam thus introduced in the intermediate reservoir upon the small piston and to provide for the absence of a retaining valve, Herr Lindner makes in the slide-valve two small holes of about 1 sq. cm. in section, as is shown in fig. 11. In starting, steam from the intermediate reservoir can thus reach the two faces of

Fig. 11.



the small piston when it is not in position to be acted upon by the steam from the boiler, and which is thus put in equilibrium. These openings are so small that they have no effect when the engine is running. In some engines, instead of the valve above described, Herr Lindner has used an arrangement opening an auxiliary passage to the intermediate reservoir, which is similar to the first arrangement adopted by Von Borries. As to this apparatus, the questions in discussion are, whether its efficiency is as great as that of the automatic retaining valve, and whether the necessity of throwing the reversing lever forward to its full extent is not more troublesome than the working of a small lever. Krauss, at Munich, has modified this apparatus, replacing the passages in the valve by the addition between the valve and the intermediate reservoir of a small valve, or rather of a flat plate which receives its motion from the cross-head of the small cylinder. When the piston is about at the middle of its stroke—that is, in position to start—this plate closes the passage of steam from the boiler to the intermediate reservoir and prevents any counterpressure behind the small piston; if, on the other hand, it is at the end of the stroke, the large piston

is in good position, and the plate, opening the passages at the end of its course, allows steam from the boiler to enter the intermediate reservoir and consequently the large cylinder. This ingenious arrangement produces the same effect as an intercepting valve, but it is complicated, and requires the use of parts continually in motion.

The arrangements of the throttle valve in fact can be multiplied indefinitely, as each builder and each master mechanic has his own.

To resume the main question: On one side we have automatic apparatus permitting the starting without special working by the engineer, but reducing to an exceedingly short period the direct action of the steam; and, on the other, non-automatic apparatus allowing the direct working to be continued until the locomotive acquires its full speed, and giving besides a certain security against accidents always possible in running, as experience has shown. The advocates of the first claim that in the second there is a certain complication and the necessity of a special motion by the engineer, and moreover there is the possibility that the engineer may waste steam by continuing direct working longer than is necessary. On the other hand, it is said that automatic apparatus, apparently simple, become more and more complicated by the additions made to them in order to give them the necessary security, so that in the end they become much more complicated and give the engineer much more trouble than the necessity of making a simple movement of the lever, and that moreover they really deprive the engine of one of its most essential qualities. As to the fear of wasting steam, Mr. Urquhart says, "As to the possibility of a waste of steam by improper use of the starting valves, we are guaranteed against that by the premiums paid to engineers, which lead them to look to their own interests and not to use this valve more than is necessary." On the Southwest Russian Line, where no automatic apparatus is used, no trouble has ever been found in this way. It may be noted here that, although the economy obtained on these Russian lines is very considerable, it is not as great as it might be were they permitted to employ higher pressures.

REVERSING APPARATUS.

When the ratio between the volumes of the cylinders of a compound locomotive is comparatively low—that is, 1 : 2 or near that—it is necessary to give the two cylinders different admissions. The reasons are so well known that it is hardly necessary to repeat them here.

The first three locomotives on the Biarritz Railroad had a very high ratio—1 : 2.78—so that this question was not considered. On the following two, which had a much smaller ratio, a system was used permitting us to vary the cut-off separately on each cylinder, while leaving the two distributions joined to one reversing lever. This apparatus was also employed on the test engine of M. De Borodine and on several others, and also on Engine 701 of the Northern Railroad. The arrangement was modified by M. De Borodine on several engines in a very neat way by the use of a hollow screw inside of the large screw used for

Fig 12.

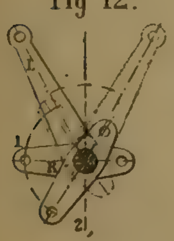


Fig. 14.

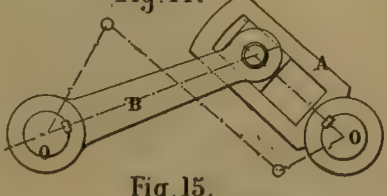
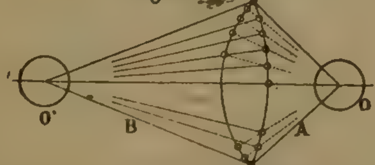


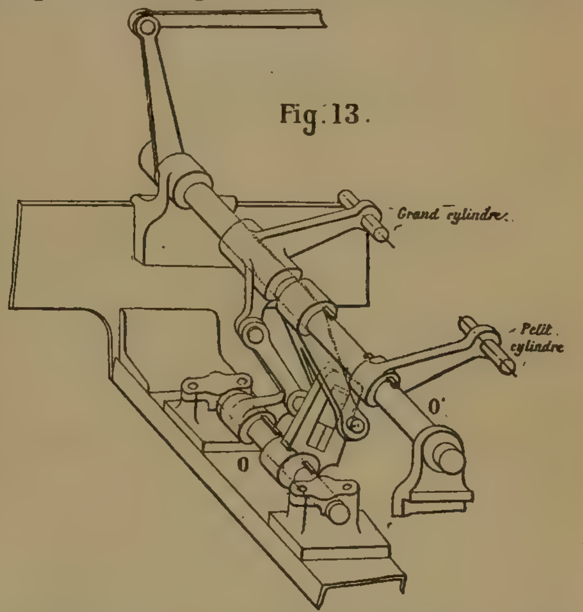
Fig. 15.



working the reversing lever, the screw containing a second one which commanded the admission of steam to the small cylinder. It is certain that the ability to give, under all conditions of working, the proper admissions to the two cylinders, permits us to secure not only the most economical results, but also the maximum power in compound working.

It is not less certain, however, that if the engineers do not follow to the letter the instructions which are given them and do not use exactly the proper cut-off, they will get a bad result. This objection was presented against my apparatus by M. Von Borries with some reason; he employed on his first small engines a similar arrangement, but has since used a system varying the admission of steam to the cylinders automatically. This consists in giving a different angle to the levers from which the links

Fig. 13.




are suspended, as shown in fig. 12, or a different length to the link hangers. It will be seen that when the lever *L* is moved toward the right from the position shown in full lines to that shown in dotted lines, the lever 2 will move its link less quickly than the lever 1.

In forward motion the cut-off obtained for the two cylinders is as follows:

| | Admission, per cent. of stroke. | | |
|---|---|---|---|
| High-pressure cylinder | 0.75 | 0.40 | 0.20 |
| Low-pressure cylinder | 0.75 | 0.50 | 0.33 |

The backward movement, however, is completely sacrificed. Sometimes this is not important, but this is not always the case, and it may be a very serious objection. I have obviated this by a differential arrangement, the principle of which is explained in figs. 14 and 15.

A shaft *O* carries a lever *A*, forming a link, the axis of which is at the extremity of a lever *B*, which is keyed upon the shaft *o*. If the system is moved between the extreme points represented in fig. 15 it will be seen that the angular displacements of the lever *A* are less rapid than those of the lever *B*. If then *o* is the reversing shaft and the link of the small cylinder is suspended from the lever *B*, and that of the large cylinder from the lever *A*, we would have a longer admission to the large cylinder than to the small, as in the Von Borries arrangement; but the points will be the same for both and the proportion of the admissions the same whether working backward or forward. Generally the arrangement has been to place the hanger of the link for the large cylinder on the main shaft and to connect it with the auxiliary shaft by a system of levers, as shown in fig. 13. The link of the large cylinder is then suspended from a lever loose upon the reversing shaft and worked by a differential movement. This arrangement, which is shown in fig. 13, was first applied to Engine 102 of the Swiss Western Railroad and succeeded perfectly. It is also used in Austria and on the compound engine of the French State Railroads which was at the Exposition of 1889. It was recently applied by Herschel & Sons, at Cassel, to compound engines built for the Prussian State Railroad.

To appreciate the better result from this arrangement over that by suspension from levers placed at different

angles, the following table is reproduced from a German paper, giving the relative admissions to the two cylinders in the two cases and in both directions. The distribution was made by a straight link and an Allan valve.

| First Suspension. | | | | Improved Suspension. | | | |
|---|---|---|---|---|---|---|---|
| Forward Motion. | | Backward Motion. | | Forward Motion. | | Backward Motion. | |
| H. P. Cylinder. | L. P. Cylinder | H. P. Cylinder. | L. P. Cylinder. | H. P. Cylinder. | L. P. Cylinder. | H. P. Cylinder. | L. P. Cylinder. |
| 0.80 | 0.82 | 0.80 | 0.78 | 0.80 | 0.80 | 0.80 | 0.80 |
| 0.70 | 0.74 | 0.70 | 0.67 | 0.70 | 0.70 | 0.70 | 0.75 |
| 0.60 | 0.65 | 0.60 | 0.55 | 0.60 | 0.66 | 0.60 | 0.68 |
| 0.50 | 0.59 | 0.50 | 0.43 | 0.50 | 0.58 | 0.50 | 0.60 |
| 0.42 | 0.51 | 0.40 | 0.32 | 0.40 | 0.50 | 0.40 | 0.50 |
| 0.31 | 0.43 | 0.31 | 0.21 | 0.30 | 0.40 | 0.30 | 0.34 |
| 0.20 | 0.32 | 0.20 | 0.12 | 0.20 | 0.24 | 0.20 | 0.27 |

In certain machines the lap and lead are made less in the valve of the large cylinder, so that the admission of steam continues longer for this cylinder than for the small one, and it is thus necessary to give more motion to the eccentrics. This is, however, a solution less satisfactory, in view of the proper utilization of the steam.

When the ratio of the volume of the two cylinders can be made 1 : 2.25 or over, the distribution can be made the same for both cylinders, and this is doubtless the simplest and best solution. Unfortunately it cannot always be adopted, because there is sometimes a limit to the diameter which can be given to the large cylinder.

What we have just said does not agree with the conclusions reached by M. de Borodine, who thinks that it is impossible to find permanent combinations for the two cylinders which shall be available at all speeds and at all pressures. I do not indeed think anything of the kind, but that we ought to seek at the same time to avoid too great an inequality of work in the two cylinders and too great a fall of pressure between them, and any arrangement which will secure this double condition within practical limits and automatically should be preferred to a disposition which is more perfect in theory, but leaves more to the action of the engineer.

The only detail which we have still to consider is the intermediate reservoir. This is generally formed by the steam-pipe connecting the two cylinders, which is placed in the smoke-box and curved so as to follow its upper surface. This is the arrangement which was first employed in the Biarritz engines, and which has been everywhere copied. An exception is found in some of Von Borries' passenger engines, where the cylinders being placed considerably back of the smoke-box, were joined by a cylindrical reservoir under the boiler. In certain recent German engines also the connecting steam-pipe passes outside of the smoke-box. Finally, in the Saxon State Railroad engines, or at least in some of them, the steam-pipe forming the intermediate reservoir passes for a certain distance through the steam space of the boiler.

The heating of the intermediate reservoir is certainly useful, especially when it can be secured without cost by using the gases in the smoke-box, and not by taking it from the steam of the boiler, but it is not necessary to try to obtain this heating by long circuits, complicated and requiring numerous joints, because in that case more is lost by the resistance to the passage of the steam than is gained by heating it. This is confirmed by marine practice, where intermediate heating has been completely given up and engineers try to make the steam passages from one cylinder to another as short as possible. The best solution for locomotives is simply to cross the smoke-box when the position of the cylinders permits it, which is generally the case.

OBJECTIONS TO THE TWO-CYLINDER TYPE.

Before quitting the subject of compound locomotives of the two-cylinder type, it seems best to examine briefly two objections made especially to this type. I have said in 1877 that the only limit to its use was in the dimensions which it was possible to give the large cylinder. This limit was found much more distant than I thought at that time. We have been able to build compound engines of two cylinders of all the existing types having from one to

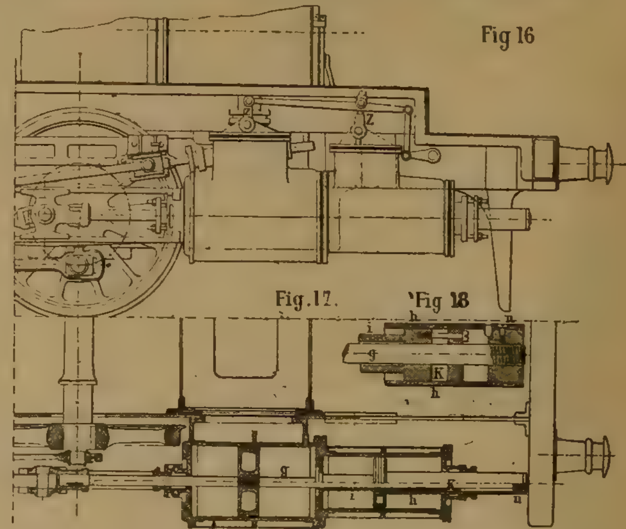



Fig 16 Fig. 17. Fig 18

four pairs of driving-wheels. The large cylinders of 25 or 26 in., for heavy engines with six drivers coupled, correspond to cylinders of 17 or 18 in. of ordinary engines, with a ratio of 1 : 2.08. Large cylinders of 26 to 28 in.,

Fig. 20.

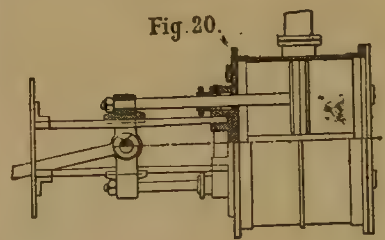
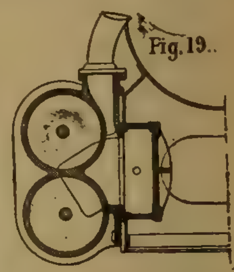
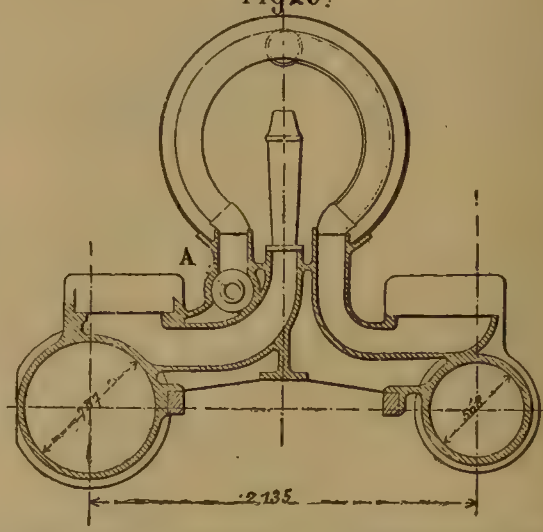


Fig. 19.



giving ratios of about 1 : 2, are employed on eight-wheel coupled engines having ordinary cylinders of 18 to 20 in.; engines which have been built in considerable numbers for the Russian Railroads with a weight of 45 to 50 tons.

Fig 29.




Mr. Worsdell has been able to use between the frames an inside cylinder of 20 in. and one of 28 in. by inclining the axis of one cylinder in one direction and of the other cylinder in another, reducing, it is true, the ratio of volume to 1 : 1.96.

There was recently built in the United States by the Schenectady Locomotive Works a compound engine of which fig. 29 gives a cross-section, and of which the low-pressure cylinder has the large diameter of 29 in. We give here the principal dimensions of this engine, which has given most excellent results, and which seems to be a starting-point for the extended application of the principle of double expansion in America: Grate surface, 28.5 sq. ft.; heating surface (fire-box, 137; tubes, 1,540), 1,677 sq. ft.; working pressure, 180 lbs.; high-pressure cylinder, 20 × 24 in.; low-pressure cylinder, 29 × 24 in.; ratio of volumes, 1 : 2.1; diameter of drivers, 68 in.; weight on drivers, 97,000 lbs.; total weight, in working order, 126,800 lbs. This engine has six driving-wheels and a four-wheel truck.

This machine is provided with an automatic starting valve invented by Mr. Pitkin, placed at *A*. The same shops are now building several consolidation engines with the same arrangement and the same size of cylinders.

Fig 32

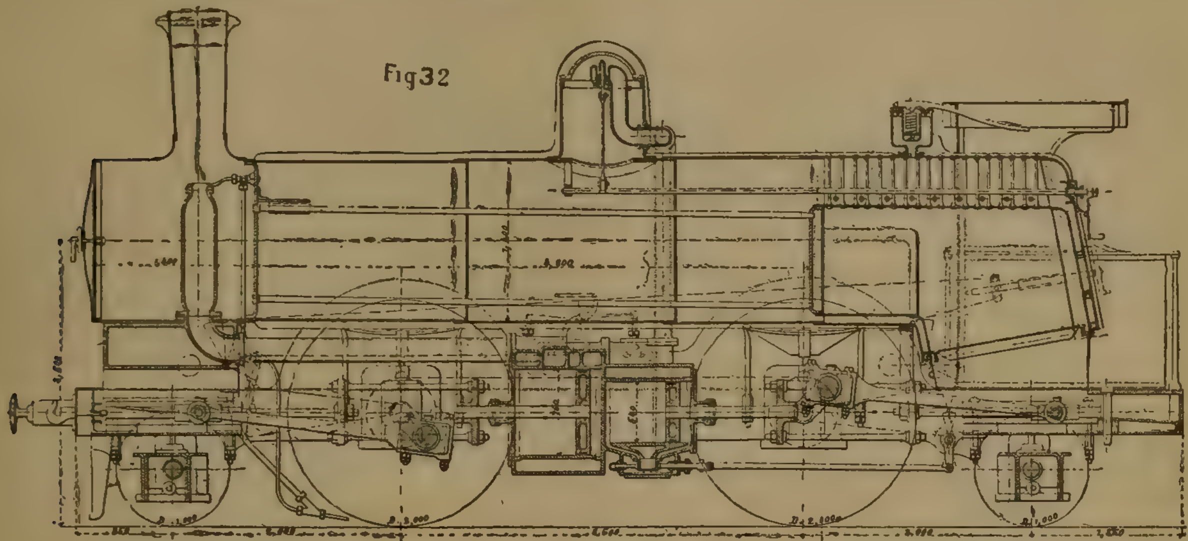


Fig 33

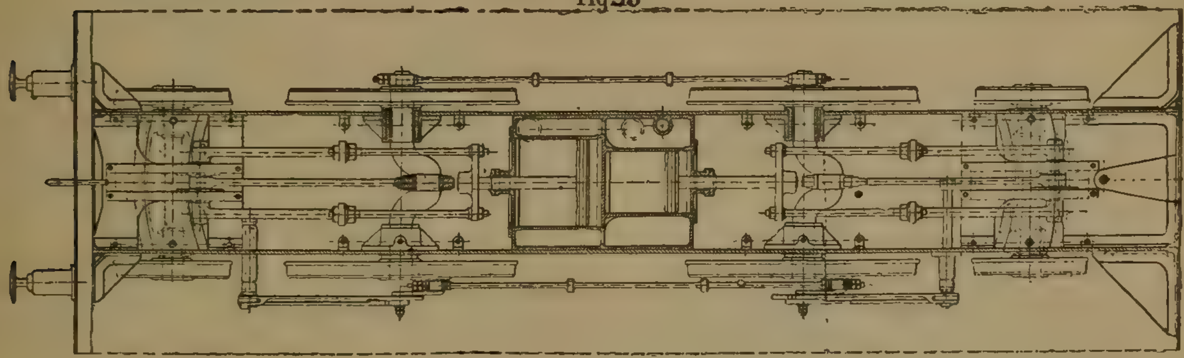


Fig 34

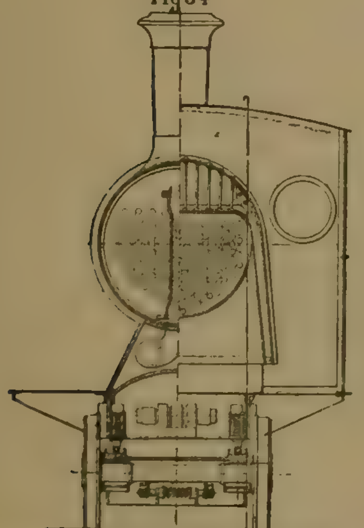


Fig 35

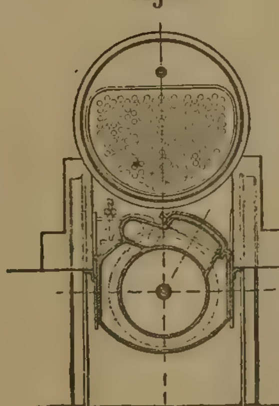
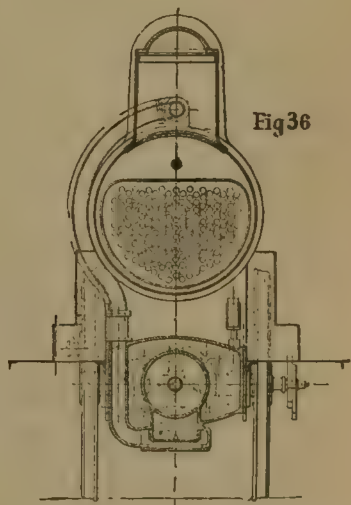


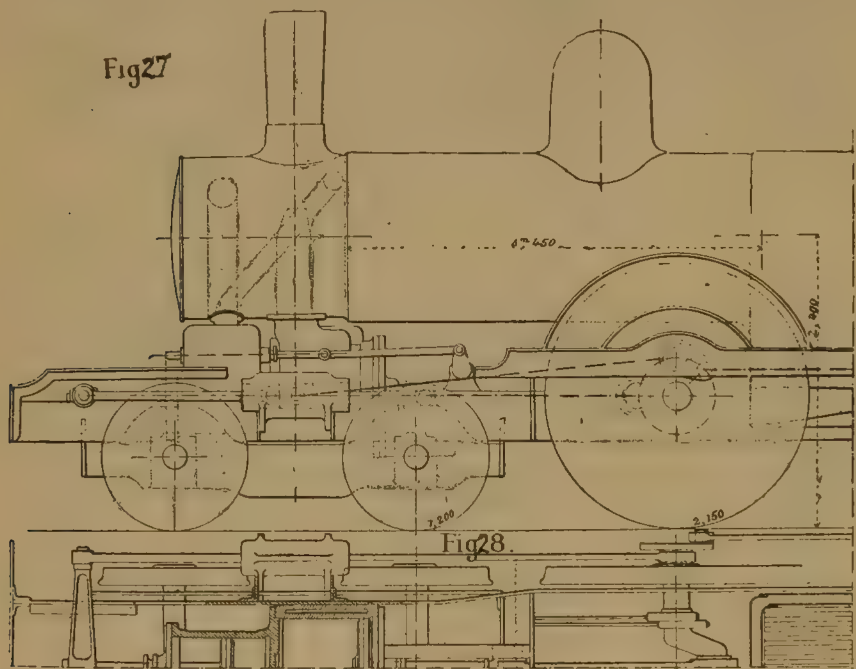
Fig 36



Generally the size of the cylinders is limited more by the position of the frames than any other cause, and therefore it is usually more easy to increase it in new engines than in old engines which have been changed.

Many ways have been considered of giving the large

cylinder sufficient size, not only to obtain the necessary power, but also to realize a ratio of volumes which will permit us, on the one hand, to simplify the distribution and, on the other, to utilize properly the higher pressures which the present tendency is to employ on railroads. I have suggested several years ago the plan, shown in figs. 19 and 20, of doubling the large cylinder and replacing it by two so placed as to work from a signal valve. This is the arrangement recently brought forward by Lapage as new. Another plan made by me in 1879, and shown in figs. 16, 17 and 18, is that of placing the cylinders one before the other or in tandem, which presents the double advantage of permitting the use of considerable diameters, and by applying all the power in the axis of the machine, of freeing the engine from transverse vibrations, even at very high speeds. Another arrangement which I have planned is shown in figs. 27 and 28, where the large cylinder is connected directly to the axle and the small cylinder, by a long crosshead and exterior connecting rods, works upon crank-pins placed in the wheels at an angle of 90° to the central crank. The parallel rods or coupling rods are connected to crank-pins placed 45° from the main crank-pin, one in




one direction and the other in the other, so that they are at right angles, according to the ordinary practice. In this plan, figs. 27 and 28, the cylinders were 21¼ in. and 31⅞ in. in diameter, giving a ratio of 1 : 2.25. The stroke was 24 in., and the driving-wheels 7 ft. in diameter. The engines would weigh about 50 tons in service, 30 tons being on the driving-wheels, and the boiler pressure would be 160 lbs.

Another arrangement, which was studied out by my colleague, M. Bronner, is represented in figs. 32, 33, 34, 35 and 36. Here the cylinders are at the same time in the longitudinal axis of the engine and in its center—that is, at the point most favorable for stability. The engine works directly on one axle, and on the other by means of a long crosshead and connecting-rods, while the two axles are coupled by outside rods in such a way as to keep the relative position of the cranks at 90°. The dimensions and weight would be about the same as for the type just mentioned. As the strain upon the coupling-rods would be very slight, except in starting, there would be no objection to giving them a considerable length.

The objection based upon the want of symmetry of the two-cylinder engine has disappeared by experience. It really never had much weight, and originated probably in a remark made by Mr. Webb, which was repeated by others, who did not understand its real purport.

(TO BE CONTINUED.)

## HIGH EXPLOSIVES FOR MILITARY USE.

(From the New York *Times*.)

THE announcement that a special gun is under construction at the Washington Ordnance Yard for the purpose of using shells charged with emmensite sufficiently indicates the hopes that are entertained by the Navy Ordnance Bureau of this new high explosive. The system of armor for our ships is now practically settled ; so is that of our heavy guns ; while even the question of projectiles is also far advanced toward solution. The factor in the aggregate problem which hitherto has not kept progress with the rest is that of powders, and thus far we have adopted no equivalents for the nitrate compounds now extensively employed in Europe both in small arms and in artillery, and for the high explosives coming into use there, as the bursting charges of shells. Possibly one reason for the comparative slowness of advance in the latter direction may have been the hopes entertained of the pneumatic gun for naval purposes. The success of this weapon, with its short range but enormous charges, as mounted in land forts, is already assured, but as to its naval uses Secretary Tracy in his recent reports says that the *Vesuvius* "is still an experiment, the trial of her dynamite guns and the tactical test of the ship having been delayed by the want of projectiles, which the company has thus far been unable to supply." In these circumstances, and with the progress made elsewhere in using shells filled with high explosives in ordinary powder guns, capable of horizontal firing, which have a great advantage not only in range, but in not being built into the ship, like the pneumatic tubes, attention has again been directed to securing some such material for our own Navy.

Of the foreign high explosives thus far employed the one which has probably attracted most attention is mélinite, used by the French. In the 6-in. gun the projectile weighs 121 lbs., and contains a bursting charge of this high explosive weighing about 23 lbs. Such a shell used in an ordinary gun must be exceedingly effective. Its safety in manufacture and use appears to be almost unquestioned, only one accident having occurred in its employment during a period of several years, while any danger is diminished by filling the larger part of the shell with a substance called cresilite. In England there have been numerous experiments with a somewhat similar high explosive known as lyddite, and a shell is credited with having penetrated a 5-in. steel plate before the charge exploded. In both these high explosives picric acid is a chief constituent, so that the former objection that this substance would explode immediately upon concussion must have been partly obviated, since some degree of penetration can be effected before the bursting. Austria's high explosive, adopted in her army, is ecrasite, a composition of blasting gelatine with some other ingredient. A shell filled with it has been fired through 6 in. of armor plate and exploded on the other side, and while nearly a half more powerful than dynamite, it appears to be safe to handle.

Such examples, making full allowance for erroneous information, due to the secrecy with which experiments are invested, produce the conviction that the use of high explosives as the bursting charges of projectiles fired from ordinary guns is likely to be a feature of warfare in the near future. Emmensite, with which our Navy authorities are experimenting, is described by them as being composed of equal parts of nitrated carbolic acid, nitrate of soda,

and nitrate of ammonia. That it is far more powerful than gunpowder has been demonstrated. Like ecrasite it can be used in small-arm cartridges as well as in heavy shells, and when classed among the nearly smokeless powders is called gelbite, which is in the form of a thick yellow paper treated with emmensite. Its propulsive force is said to be as 14 to 5 compared with ordinary powder. The testimony as to its safety under concussion is decided, large cartridges of it having been hit by shots from a rifle without exploding, while it has also been fired through a 2-in. board and no explosion resulted.

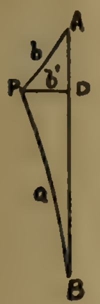
Of course the real possibilities of this high explosive can only be known after its final tests by the Ordnance Bureau with the new gun, which is to be shorter than the service piece of the same caliber, and more like a long rifled mortar. And while these experiments are going on in the Navy, the Army, through the Board on Magazine Small Arms, will be testing the Belgian Wetteren powder. Other high explosives and smokeless powders may enter into competition with these, and the coming year will see experiments with powders and magazine guns forming an interesting sequel to those of the present year with armor and projectiles.

## A NOTE FOR SURVEYORS.

By Seth Pratt, C.E.

There is given below a new method of finding the azimuth of Polaris.

Most land surveyors lack the facilities for obtaining a meridian by the method of double altitudes of the sun or a star, and during portions of the year are unable to obtain the azimuth of Polaris by its elongations.




This *new method of finding the azimuth* at the instant that Polaris and any one of the bright circumpolar stars are in a perpendicular plane may be used when other methods are inconvenient or impossible. It consists in ranging out their direction at the time of their perpendicularity or when they are behind a plumb line, suspended with a weight. The data for this purpose being the star's polar distances and right ascensions, the date and the latitude of the place.

Let $A\ B\ P$ represent a spherical triangle revolving about the celestial pole of the earth, $P$ the pole, $A$ the place of Polaris, and $B$ that of another star, and let the side $A\ B$ be supposed to be in a perpendicular plane, passing through the place of an observer in a given latitude.

The polar distances give the sides $A\ P$ and $B\ P$, and the *difference* of the right ascensions reduced to arc gives the angle $A\ P\ B$.

Subtract the right ascension of Polaris from that of the other star, borrowing 24 hours if necessary.

If the result be $\left\{ \begin{matrix} \text{less} \\ \text{greater} \end{matrix} \right\}$ than 12 hours, the az. is $\left\{ \begin{matrix} \text{E.} \\ \text{W.} \end{matrix} \right.$

The angle $A\ P\ B$ is *either* the difference of the right ascensions reduced to arc, or the supplement of 360°, *always* to be taken out less than 180°.

To find the angles $A$ and $B$ we have, by the first and second of Napier's Analogies,

$$\text{cos.}\ \tfrac{1}{2}(a+b) : \text{cos.}\ \tfrac{1}{2}(a-b) :: \text{cot.}\ \tfrac{1}{2}P : \text{tan.}\ \tfrac{1}{2}(A+B).$$

$$\text{sin.}\ \tfrac{1}{2}(a+b) : \text{sin.}\ \tfrac{1}{2}(a-b) :: \text{cot.}\ \tfrac{1}{2}P : \text{tan.}\ \tfrac{1}{2}(A-B).$$

Then will

$$\tfrac{1}{2}(A+B) + \tfrac{1}{2}(A-B) = \text{angle } A,$$

and

$$\tfrac{1}{2}(A+B) - \tfrac{1}{2}(A-B) = \text{angle } B.$$

Draw $P\ D$ perpendicular to $A\ B = b'$. Then, by Napier's rules for the *circular* parts, we have,

$\text{sin.}\ b' = \dfrac{\text{sin.}\ A.\ \text{sin.}\ b}{R} = \dfrac{\text{sin.}\ a,\ \text{sin.}\ B}{R}$, and cos. lat. : $R$ :: sin. $b'$ : sin. azimuth ; or, reducing these two proportions to an equation, sin. azimuth $= \dfrac{\text{sin.}\ A,\ \text{sin.}\ b}{\text{cos. lat.}} = \dfrac{\text{sin.}\ a,\ \text{sin.}\ b}{\text{cos. lat.}}$ (check).

Example: Required the azimuth of Polaris and Gamma, February 1, 1891, in lat. N. 40° 42'. 5.

Gamma, $R.\ A. =$ $0^h\ 50^m\ 6.^s62$ $P.$ dist. $= 29°\ 52'.046 = a.$
Polaris, $R.\ A. =$ $1^h\ 18^m\ 54.^s51$ $P.\ D. = 1°\ 16'.337 = b.$
$23^h\ 31^m\ 12.^s11$ sin. $a = 9.697225$
$P$=supplement of $24^h = 28^m\ 47.^s89$ sin. $b = 8.346427$

$\tfrac{1}{2}P$ in arc $= 3°\ 35'.98625$ cot. $= 11.201276.$
Lat. N. 40° 42'.5 cos. $= 9.879692.$

$\tfrac{1}{2}(a+b) = 15°\ 34'.019 \left\{ \begin{matrix} \text{cos.} = 9.983734 \\ \text{sin.} = 9.428726 \end{matrix} \right.$
$\tfrac{1}{2}(a-b) = 14°\ 17'.854 \left\{ \begin{matrix} \text{cos.} = 9\ 986336 \\ \text{sin.} = 9.392419 \end{matrix} \right.$

cos. $\tfrac{1}{2}(a+b)\ a.\ c.$ .016266
cos. $\tfrac{1}{2}(a-b)$...... 9.986336
cot. $\tfrac{1}{2}P$............ 11.201276
tan. $\tfrac{1}{2}(A+B) =$ 11.203878
86° 25'.3

sin. $\tfrac{1}{2}(a+b)\ a.c.$ .571274
sin. $\tfrac{1}{2}(a-b)$.... 9.392419 sin. $A$=9.115182 sin. $a$=9.697225
cot. $\tfrac{1}{2}P$........ 11.201276 sin. $b$=8.346427 sin. $B$=7.766120
tan. $\tfrac{1}{2}(A-B)$= 11.164969 17.461609 17.463345
86° 5'.237 cos. lat. 9.879692...... 9.879692
sum $= A =$ 172° 30'.537 sin. $Az.$=7.581917 (check) 7.583653
sup. 7° 29'.463 sin. = 9.115182 $Az.$=13'9"W.
diff. $= B =$ 0° 20'.063 sin. = 7.766120.

## THE GOVERNMENT SURVEYS FOR THE GREAT SIBERIAN RAILROAD.

By A. Zdziarski, Engineer.

(*Concluded from page* 59.)

### V.—THE SOUTH OUSSOURI RAILROAD.

While the building of this road is for the present postponed, in 1887 it was considered a very important line, and the surveys were made in the years 1887 and 1888.

The South Oussouri Railroad, the Pacific link of the Great Siberian Railroad, is intended to connect the Amour watershed with the Pacific, or more explicitly, the Oussouri, a tributary of the Amour, with the port of Vladivostok. The terminal point on the Oussouri was to be either Grafskaia or Bousse, since below those points there is no obstacle to navigation.

Surveys were made in two directions. One followed the western slope of the peninsula, traversing the valleys of the Otinovka and Lefou rivers, crossed the Oussouri and followed its valley to Grafskaia. The other passed through the middle of the peninsula, crossing the central divide, then followed the valley of the Dombikhe River, crossing the Oussouri and ending at Bousse.

The first of these lines—Vladivostok to Grafskaia—is the better line for traffic, more easy to build, and estimated cheaper by 13,000,000 roubles. It will, therefore, require a more complete description.

The whole length of the main line from the station Mouraviev-Amourski, near Vladivostok, to the station Grafskaia is 256 miles, to which must be added the branches or extensions to the harbor of Vladivostok and the port or landing on the Oussouri, making 261 miles in all.

The main line of 256 miles is considered a level section, and will have maximum grades of 0.8 per cent., and a minimum radius of curvature of 1,050 ft. The port extension or branch at Vladivostok will have grades of 2 per cent. and curves of 700 ft. radius.

The greatest distance between water stations was fixed at 18 miles, in order to permit the running of seven trains daily each way, but the estimated supply of rolling stock is for three daily trains only.

The average quantity of earthwork will be 38,000 cub. yds. per mile, of which about three-quarters is in embankment and one-quarter in cutting. On the port branch the earthwork will be about 100,000 cub. yds. per mile. There will be required retaining walls at several points, some of dry masonry and some in mortar masonry.

Two tunnels will be required, one 665 ft. long, on the 13th mile, the other 1,090 ft. long, on the 32d mile.

There will be a few arch culverts and a number of small bridges of 7 ft. span, of wood. The rest will be of iron and will be as follows: 66 bridges of spans from 14 to 56 ft.; 1 deck bridge, 70 ft. span; 4 through bridges, 70 ft. span; 1 through bridge, 84 ft. span; 3 of 105 ft.; 1 of 140 ft.; 3 of 175 ft.; 3 of 210 ft.; finally one bridge, over the Oussouri River, with 7 spans of 252 ft. each.

tanks will be placed at 20 points, 11 regular stations and 9 sidings. The supply is everywhere abundant, from rivers, ponds and springs. The tanks will be of 2,744 cub. ft. capacity and the general arrangements the same as on the other lines.

The station yards will be paved and fenced and the stations fully supplied with signals, switches, etc. There will be five Sellers turn-tables of 55 ft. diameter, seven smaller turn-tables, three weigh-bridges and 60 switch-houses.

The supply of rolling stock, for three daily trains, will be 29 six-wheeled, 32-ton locomotives; 20 eight-wheeled, 42-ton locomotives, making 49 locomotives in all; 47 passenger cars and 372 freight cars. Sufficient repair shops will be provided.


THE SOUTH OUSSOURI SECTION OF THE GREAT SIBERIAN RAILROAD.

The total amount of masonry required will be about 105,000 cub. yds., while for the superstructure 5,000 tons of iron will be needed.

The length of sidings will be 11 per cent. of the length of main line.

The rails will be of somewhat light type, 54 lbs. Russian (49 lbs. English) to the yard. There will be 2,400 ties to the mile and 2,300 cub. yds. of ballast. Ballast is very scarce along the line.

The road buildings will be all of wood; they will include 36 section-houses, 21 double and 96 single watchmen's houses.

There will be 12 stations: one first-class (terminal); two second-class; one third-class and eight fourth-class; besides these there will be nine sidings with water tanks.

There will be four engine-houses with 30 stalls. Water

The cost of the line, 261 miles, is estimated at 24,000,000 roubles, or 92,000 roubles per mile.

The second line explored, from Vladivostok to Bousse, through the center of the peninsula and by the valley of the Dombikhe, is much more expensive and difficult. On the first 30 miles it requires 17 tunnels of from 350 ft. to 10,000 ft. in length, and many viaducts, some as high as 250 ft.; its estimated cost is 37,000,000 roubles. Moreover, it will have grades of 2 per cent., and curves of 1,050 ft. radius.

The Oussouri country has a moderate climate, generally a fertile soil; the rivers are abundant, the forests are full of large trees, and there are valuable mineral deposits; so that the country is capable of great development and has a promising future. At present the population is small, and labor difficult to secure; for this reason the estimated

cost of the railroad is much higher than for a similar line in European Russia.

VI.—GENERAL SUMMARY.

The total distance from the present railroad terminus, at Tumen, on the Toura, in Western Siberia, to the port of Vladivostok, on the Pacific, by the line adopted, will be as follows:

| | Miles. |
|---|---|
| Tumen to Tomsk, by steamboat on the Toura, Tobol, Irtish and Obi rivers | 1,870 |
| Tomsk to Sretensk, railroad | 1,895 |
| Sretensk to Grafskaia, steamboat on the Shilka, Amour and Oussouri rivers | 1,590 |
| Grafskaia to Vladivostok, railroad | 261 |
| Total | 5,616 |

The line will at first be made up of 2,156 miles of railroad and 3,460 miles of river navigation; but, as before stated, there is little doubt that the distance from Tumen to Tomsk will be filled by a railroad line starting either from Tumen or Chelabinsk. This will considerably shorten the distance, and will leave only the 1,590 miles of steamboat navigation on the Amour, which is very much better and less interrupted by winter than on the Obi and its tributaries.

That the railroad will be of great service to the Government, and will assist very much in developing the country there can be no doubt. As the longest continuous line in the world, it merits the attention of engineers everywhere.

## A NEW STEEL TIE.

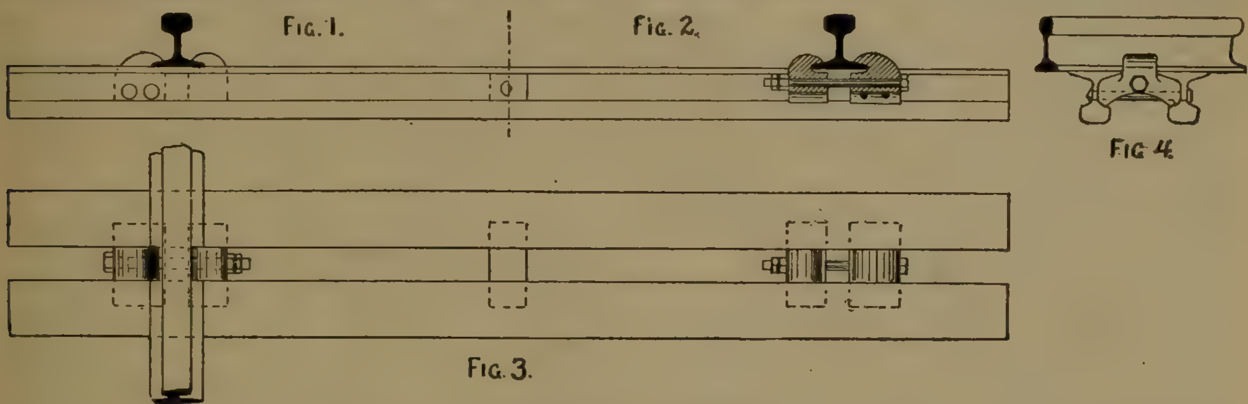
THE accompanying illustration shows a form of tie proposed by a correspondent, Mr. E. A. Cannon, of Minneapolis. Fig. 1 is a half elevation; fig. 2 a half cross-section; fig. 3 a plan, the rail being shown in place on one side, but removed on the other; fig 4 an end view. The advantages are named below. The sketch is given as a contribution to the solution of the tie question.

This plan is devised with the idea of utilizing material which all railroads have in plenty—old, worn-out rails. The description, with the illustration, will, it is believed, make the idea perfectly plain.

Material used to be old rails cut the required length, and four bolts, or two bolts and four rivets; more bolts can be used, if deemed necessary. Two pieces of rail are used for each tie, with the castings between them fastened together with screw-bolts or rivets. When in position the rail will be bottom side up, giving a broader bearing surface, and because the heads of old rails are usually very uneven. The *outside* casting on each side is intended to be stationary, fastened with bolts or rivets passing through it and the pieces of rail. The inside casting on each side is movable, so that the rail can be put in place easily. It is then drawn up and held in place by a screw-bolt, as shown; or a key can be used, if it is preferred or considered necessary.

Another casting or packing piece may be needed in the center, and one is shown in the drawing; this seems hardly necessary, but if desired it can be put in, as shown, at small cost, and will certainly give additional bearing.

Two rivets are shown in the drawing at each end, but probably one would be enough, or a bolt may be used instead, as noted above. The tie would give plenty of bearing in the ballast and a broad surface for the rail. Probably the most convenient length would be 7ft. 6 in.; that is, a 30-ft. old rail would cut into four pieces, making two ties.




A TIE OF OLD RAILS.

## OUR NAVY IN TIME OF PEACE.

By LIEUTENANT HENRY H. BARROLL, U. S. N.

(*Continued from page* 67.)

THE WAR COLLEGE AND TORPEDO STATION.

THE Naval War College and the Torpedo School are located at Newport, R. I. They were formerly two separate institutions, but in 1889 were combined under one management. The Station is under the direction of the Bureau of Ordnance.

These may be considered as post-graduate courses for those who have completed the term of study at the Naval Academy, although in some cases years elapse before the Academy graduate has the advantage of these latter courses. The War College, as its name implies, is for the purpose of imparting a closer knowledge of the art of warfare.

The painter or sculptor requires not only long practice before accurately posed models, but also close study of the finest works of other celebrated artists, before being able himself to picture the dew upon a rose leaf or to chisel from cold marble the life-like features of a Greek slave.

The art of warfare, likewise, requires that nothing be neglected, no pathway be left unexplored which may bring to light the best qualities of officers and seamen. All other sciences have in late years developed themselves into numerous specialties, to meet the requirements of the greater minuteness to which each branch of that profession has attained; and in like manner, among those who have made it a close study, naval warfare produces specialists in each of its several lines of duty.

Among the specialties to which modern warfare has given birth, and the details of which cannot be mastered by each individual officer, may be mentioned:

1. The more perfect designing of vessels, with finer lines, greater speed, a more complete angle of fire, a more compact arrangement of internal compartments, engines, coal-space, magazines, etc., whereby the greatest benefit is obtained from the allowed displacement.

2. Electrical engineering—invention, manufacture and use of torpedoes; the use of electricity for lighting ships; for guiding and exploding torpedoes; for search lights, to guard against torpedoes; for finding the range of the enemy; for signalling; for working and firing machine guns.

3. Attack by ramming or by torpedoes, and defense

against the same; tactical diameter of vessels and the maneuvering under different conditions, either to crush a hostile vessel or to avoid her deadly prow; the rigging of torpedo gear, wire nettings, booms, etc., to protect a vessel, and the various methods of destroying such protection of the enemy.

4. Invention and manufacture of high-powered steel, rifled cannon; rapid-fire guns; top-defense, or the defense by machine guns, mounted in steel-clad tops, supported upon military masts, against a possible attack of the vessel by torpedo boats; the manufacture of the highest grades of steel; inclined and vertical armor, and steel-faced projectiles for piercing the same, etc.

5. A higher system of navigation than that employed in former times; a more complete mastery of the magnetic compass, to compensate for the greater masses of metal used in the construction of modern vessels and guns; the determination of geographical positions by the use of the chronograph, and the electric cable.

6. A better organization for littoral expeditions; a more efficient landing organization, better armed and equipped, having a more complete knowledge of light-artillery practice ashore and the various forms of resistance there to be met.

These are some of the changes which have in late years been wrought in naval warfare, and with them comes a discontinuance of many of the former methods practised by our naval heroes in times past.

It is now no longer politic for a commanding officer, by the exercise of his own personal magnetism, to endeavor, as formerly, to arouse the enthusiasm of an entire crew. In any service, in any age there will always be found men who, like Cæsar, Napoleon, Nelson, Paul Jones and Decatur, are able to draw, even to certain death, masses of people who are affected by this powerful magnetic force; but the willingness to thus be drawn arises from a supreme confidence in the ability of the person so urging them forward—a belief that their leader fully knows the ground over which he orders this advance.

The object of naval training should rather be the suppression of this too ardent spirit, by introducing a more cool and mechanical one, which compels the officer or seaman to execute orders in an intelligent way, while yet remembering that he is only a small part of the great war machine, whose total power is, at all times, only properly known and correctly handled in the conning-tower.

In doing this, care must also be taken not to destroy the individuality of thought of the different persons, and thus train up a class of automatons. Men have been endowed by nature with powers of reason, and these must not be obliterated, but improved and intensified by education.

Officers and seamen should not only be allowed, but expected to reason; and a commander, no matter how small his command, be required to realize the responsibility placed upon him, even in the execution of an order. No manifestly erroneous or impossible order should be attempted. The fatal mistake made by Lord Cardigan, when at Balaklava he ordered the Charge of the Light Brigade, has been severely criticised by military men, and the execution of orders so manifestly erroneous would now possibly be attended with court-martial and dismissal.

While allowed to exercise his powers of reason, each individual need not necessarily be allowed to criticise or refuse to obey the rightful orders of a superior. He should be as oblivious as possible to all that surrounds him, except to those things which concern the execution of his immediate duty; to these he should be keenly alive, and should be ready to take the utmost advantage of every natural or mechanical means at his command to further its execution. To do this he should be as calm and collected as possible. Everything with him should be a matter of fact, which had long ago been reasoned out—not in the minds of others, but in his own mind.

There is a naval story to the effect that an ancient officer, finding fault with one of his juniors, remarked in thunder tones:

"Why did you do that, sir?"

"I thought—" began the trembling unfortunate.

"Blank-it-to-blank, sir! *You thought!* What business have *you* to *think! I am put here to think for you!*"

But in later years all of this has been changed, and commanding officers now avail themselves of the brains as well as of the muscular powers of their subordinates. Ignorance, carelessness or neglect of one's duty is no more condoned at present than in that day mentioned; but the ancient officer, if he were here, would now remark:

"Blank-it-to-blank, sir! *Why did you not think it well over, before doing* ANYTHING!"

In the day of sailing ships it was considered good practice for a young officer, as he stood the deck watch, to conjure up possible disasters which might befall the vessel, and having thus brought before his mind such an emergency, to reflect upon the line of action that should then be taken.

It has become an axiom in modern warfare, that all other things being equal, the cool and collected man, who is executing a carefully studied plan, will be successful over the enthusiast, who is acting under the impulse of the moment. As evidence of this, witness the termination of the Franco-Prussian war, as contrasted with that stubborn resistance met before Richmond, after four years of hard fighting.

There can be but one opinion as to the fact that the Confederates were less prepared to withstand the advance of the Federal forces than were the French to resist the German invasion; yet while Lee, Johnston and Longstreet, by their steady coolness, even under defeat, required that overwhelming force to advance but slowly, on the other hand, the French line, "On their way to Berlin," having once been checked, Von Moltke marched steadily into Paris. It is a noticeable feature of this campaign that the handkerchiefs issued to the German soldiers had printed upon them the fortresses and the routes connecting them which lay between Berlin and Paris; thus giving each individual soldier a knowledge of the geography of the territory through which he was advancing.

Another lesson may be drawn from this contrast. One must to-day guard as carefully against an enthusiastic advance as he would against a precipitate retreat. Mathematical and mechanical exactness is of as much value in the flush of victory as during the ignominy of defeat.

It can thus be seen that the art of *applying* the more scientific principles of modern warfare is not inherent in the minds of all graduates of military and naval schools; and the proper instructors in the application of these principles are those officers who have acquired special prominence in the different branches of naval duty.

The War College, therefore, can impart a class of information not otherwise obtainable except by experience in time of actual warfare—a method necessarily disastrous to the nation's forces. Experience in the use of the constantly improving engines of war has still to be dearly bought in absolute battle. There is no school for the naval fighter to equal that of the deck of a ship in action; and our estimates of the effect of machine guns, smokeless powder, balloon torpedoes, etc., must be largely a matter of conjecture, yet by instruction from specialists in each branch of naval duty, the errors occurring in actual conflict would be reduced to a minimum.

The system of instruction consists of lectures at which notes are taken and upon which recitations are afterward required. Various professional subjects are treated of in these lectures, extending from the organization of crews and the disciplining of men, to the handling of a vessel in action or the tactics of a fleet.

The adoption of the torpedo as an offensive and defensive weapon has radically changed naval warfare. The first attempts to use torpedoes were met by the declarations of prominent statesmen, that such a method of waging war was barbarous and contrary to the international rules existing between civilized nations; yet, notwithstanding the general objection to their use, they are now universally employed.

In America torpedoes were first used during the Revolution, when an effort was made to destroy the British vessels anchored in the Delaware River by the setting adrift of a number of kegs, filled with powder, and arranged to explode by clock-work.

As these drifted down they were seen by the English vessels, and were destroyed by the fire of cannon and

small-arms. Athough the attempt was not at all successful, it caused quite a commotion in the fleet; and the circumstance gave rise to a mock heroic poem, by Francis Hopkinson, entitled "The Battle of the Kegs."

During the war of 1812 stationary torpedoes, and also a submarine boat to carry torpedoes, were designed by Robert Fulton, but the systems, though elaborated, do not seem to have been of much advantage.

The first really successful use of torpedoes may be said to have been in 1854, when the Russians by this means defended the Baltic ports.

In our civil war, 1861–65, torpedoes were largely and effectively used in the defense of the Southern ports, and in many cases were the only deterring agents to the advance of our naval forces, until Farragut, at Mobile, showed that the danger to be apprehended from them had been greatly over-estimated.

The effectiveness of the torpedo has been greatly increased, and it has now become a weapon of the utmost importance. The rough kegs of powder used during the Revolution and the more systematized iron tanks designed by Fulton in 1812 bore little resemblance to the highly scientific machines which are to-day constructed. Nevertheless, Bushnell, of Connecticut, in 1778, conceived the system which to-day we find to be the most efficient—that of a submerged or partly submerged boat carrying an explosive charge.

The earliest torpedoes were placed to defend harbors, and consisted of stationary tanks of powder. These were generally exploded by contact fuses, having small glass vials of acids, which broke when the vessel collided with the torpedo, and acting upon other chemicals, produced the explosion of the charge.

These were equally dangerous to friend or foe, and after the declaration of peace the removal of these obstructions from the harbors was generally attended with difficulty and great danger.

During our civil war, for the defense of the entrances to certain harbors, torpedoes were arranged to be exploded by the electric current. These were generally quite successful, yet on one occasion one of our monitors lay for over an hour directly on the intersection of the two lines of bearing and over a large iron tank containing 2,000 lbs. of powder, which failed to explode, owing to the imperfect insulation of the current wires.

In later years movable torpedoes began to be used; first a simple can of powder, fixed upon a spar, projecting from the vessel's side, and thus carried into action, was by electricity exploded under or close alongside of the hostile vessel. These were soon succeeded by torpedoes which were attached by long lengths of wire rope to the vessel, and which by systems of steering apparatus could be veered alongside of the enemy, and there exploded either through electric currents, led along the wire rope, or by contact fuses borne in the torpedo itself. These were found to be less dangerous to the vessel which was exploding them than were the spar torpedoes, as the latter, being discharged at such close quarters, might, owing to the sudden carrying away of a guy-rope, etc., explode the charge under its own vessel.

The later and more perfect torpedoes, which are now propelled and guided by electricity, compressed air or other gases, or by some internally carried motive-power, are known as "Auto-mobile torpedoes," to distinguish them from those which are carried upon spars or propelled by current-wires reeled out and reeled in, at will, from shore stations; while stationary torpedoes are now generally alluded to as "submarine mines."

The defense against torpedo attack may be said to have almost kept pace with the improvement of the torpedo itself, and therefore, if our naval predecessors could now return, they would find themselves confronted with an entirely new method of attack and defense. Stationary torpedoes are now exploded by means of small counter-torpedoes, the discharge of which causes the explosion of the larger ones throughout a certain area. The invention of electric search-lights and machine guns have greatly reduced the time in which the torpedo officer has a chance to execute his delicate mission; while submarine torpedo boats and "fish torpedoes," as well as the greater speed lately attained, partly compensate to him for being under such strict surveillance and so rapid a fire.

It became manifest some years ago that the invention and manufacture of these more complicated machines required a school for their study, and the Torpedo School was established at Newport, R. I., for this purpose.

Each year a number of officers of different grades are ordered here to obtain a more thorough knowledge of the subject of torpedoes. The instruction embraces all things connected with the making of torpedoes, their care and their use. Certain days are set apart during the course for practical exercise in handling and exploding torpedoes at stationary or at moving targets.

As the course includes the manufacture of all that enters into the composition of the torpedo—the charge, the fuses which explode the same, and the motive, or guiding power, a review of chemistry is necessary, in order to enable one to keep pace with those discoveries which are constantly being made in that science.

The system of instruction is also that of lectures, and recitations upon the notes then taken, and is supplemented with practical exercises.

(TO BE CONTINUED.)

## ON THE SOARING OF BIRDS.

We republish below from *Nature* a fresh attempt at a solution of the mystery of the soaring of birds; some species of which, as is well known, possess the skill of gliding upon the air almost indefinitely without flapping their wings, and without losing height.

Such birds generally inhabit southern latitudes; they soar high in the air, and the difficulty in observing accurately their movements, together with our general ignorance of the laws which govern air resistances, have thus far prevented any satisfactory explanation of this deeply interesting problem.

The present attempt is scarcely more fortunate than its predecessors. The Author omits all numerical calculations, and assumes that the bird proceeds in zigzag lines, describing a series of figures of 8, in which the return against the wind is very much shorter than the course with or perpendicular to the wind, and he assumes also practically the same conditions for spiral soaring.

In point of fact, few if any birds soar in that way. They first acquire initial velocity by flapping their wings, and then lazily float in nearly full circles, drifting but little, while surveying the field for a meal. In this climate such birds (the hawks, the eagles, etc.) give once in a while a few strokes of the wing, occasional kicks, as it were, which seem utterly insufficient to maintain their speed, particularly when rising; but larger birds, further south, are said to start from a perch, and to soar for hours without a single perceptible movement of the wings.

Some birds of passage—the sand-hill crane, for instance—give us in the North an exhibition of their powers when they start on their southern migrations. They vault into the air and flap their wings slowly but vigorously, until they have gained an altitude of 1,000 to 1,200 ft. Then, stretching their rigid wings to the utmost, they wind up in a spiral 75 to 150 ft. in diameter, without another flap, to a height of one to three miles, and often beyond the limits of vision. When satisfied with the elevation gained, and with the condition of the wind at that elevation, the bird then heads due south, and transforms the height gained into horizontal progress by gliding downward in a straight line at such an angle as to produce the speed necessary to furnish a sustaining reaction and to overcome the head resistance. When this downward course brings him inconveniently near the earth, he rises again in a spiral, to repeat the operation.

Most observers are agreed that this manœuvre can only be performed in a wind blowing at the rate of 10 to 25 miles per hour. There may be a dead calm at the surface, but as experienced by æronauts and proved by the records on the Eiffel Tower, it frequently happens that not a breath stirs below, while a good breeze is blowing 1,900 ft. above.

Granting the wind, any explanation of the phenomenon in order to carry conviction should deal with numerical

examples, and give the data for a particular case. We should know :

1. The weight of the bird.
2. The area of surface, as well as the form of that surface, and its coefficient as compared with a flat plane.
3. The velocity of the bird.
4. The velocity of the wind.
5. The angle at which the bird obtains a sustaining reaction at the speed of soaring upward.
6. The additional angle, if any, required to produce the velocity when gliding south and downward.
7. The forward head resistance of the bird.
8. The rear resistance of the bird, or coefficient of impulse which the wind can impart.

Should any of our readers possess data or views on this subject, we shall take pleasure in publishing them.

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The article above referred to, which is contributed to *Nature* by Magnus Blum, of Lund, Sweden, is as follows :

The interesting problem of the soaring of birds, though repeatedly discussed, especially in *Nature*, has not yet found a satisfactory solution. This is the explanation I propose.

Suppose that a bird soaring horizontally with a certain velocity enters a current of air cutting his own course rectangularly. The bird will be seized and partly borne by the wind. Instead of passing by calm the distance *a* to *b*, he will advance from *a* to *c* in the same space of time (see fig. 1 ; the arrow *e f* indicating the direction of the wind, and the cross-lines the length-axis of the wing-area). The way *a* to *c* evidently being longer than *a* to *b*, the bird, on arriving at *c*, has a greater absolute velocity than if he had pursued, in a calm, his course *a* to *b*. It is equally evident that, if the initial velocity of the bird and the velocity of the wind are properly adapted, the velocity of the bird at the point *c* can, in spite of the resistance of the air to his advancing, be greater than at *a*. If arriving at *c* the bird can turn against the wind * without considerable loss of velocity, it is clear that he is able to continue his new course for a short space, before his velocity sinks to the initial velocity which he possessed at the point *a*. During this part of his course, the relative velocity of the bird (with relation to the air) is more than twice the absolute velocity of the wind, supposing the initial velocity of the bird equal or superior to that of the wind. Let *d* be the point where the absolute velocity of the bird has sunk to the initial velocity. If the bird turns at *d*, so that his course crosses the direction of the wind at right angles, he is again ready to begin the same course as when starting from *a*. Thus, on the way *a* to *c* the absolute velocity increases, on *c* to *d* it diminishes as much.

Let us now suppose the direction of the wing-plane unchanged : the course of the bird will no longer lie in the horizontal plane, but, from reasons now easily understood, *a* to *c* will gradually drop down to the earth, according as the relative velocity diminishes ; on the other hand, *c* to *d* will rise according to the increment of the relative velocity. Which will be the greater, the sinking or the rising, depends on several circumstances, but principally on the force of the wind, the adaptation of the wing-plane, the size and form of the bird, and the corresponding proportions between the bearing of the wings and the resistance of the air. This resistance is, of course, in proportion to the weight, less to the advancing of large birds than to the advancing of small birds. This is the reason why large and heavy birds are the best soarers.

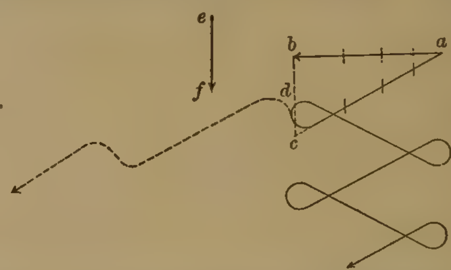
It results from this that a bird suitably built for the purpose cannot only maintain the same level without working his wings, by a uniform and moderate wind, but also gain in height by adroit movements.

It may perhaps be objected that, according to this scheme, the course of the bird will not be spiral, but run in figures of eights gradually moving in the direction of the wind or in continuous windings on the one or on the other side and partly with the wind (fig. 1). Indeed it is likely that the movements of the birds will often prove that they profit by this principle in manœuvres the purpose of which has not yet been understood.

* It has long been acknowledged that some birds possess the power of changing their direction without any sensible loss of velocity.

The spiral soaring is still to be explained. I think we must suppose that commodiousness is the principal motive thereof. Let us fancy that a bird, having acquired the necessary initial velocity, soars in a calm without working his wings, not in a rectilinear course, but by suitable inclinations and turnings of the wings in circular courses. We known that, in order to perform this manœuvre, the bird drops the interior wing a little and raises the exterior wing just as much, so that the wing-plane, during this motion, forms a conic ring, the top of the cone pointing downward. If the velocity did not diminish, the bird would be able to continue this course indefinitely, or he would rise or sink in a screw-formed course, according as the velocity should increase or diminish. By greater inclination of the wing-plane to the axis of the cone, the circles would become narrower ; by diminishing inclination, they would become wider ; both these motions are easily produced by minimal changes of the form of the wing-plane or of the place of the center of gravity. Let us further suppose that the stratum in which the bird soars is continually moving in a certain direction. From the

Fig. 1.




moment the course of the bird is perpendicular to the direction of the wind (point *a* in fig. 2) till the moment it grows parallel with it (*b*), the bird obtains from the wind an addition to his absolute velocity (not considering the loss occasioned by the resistance of the air) and also an increment of velocity from the moment his course deviates from the direction of the wind (*b*) till the moment it grows perpendicular to it (*c*). From this moment again the absolute velocity gradually diminishes, till, at last, at the point *f*, it reaches its minimum. From this point (*f*) a new circle begins identical with the first one, if the absolute velocity in *f* is the same as that in *a*, which does not

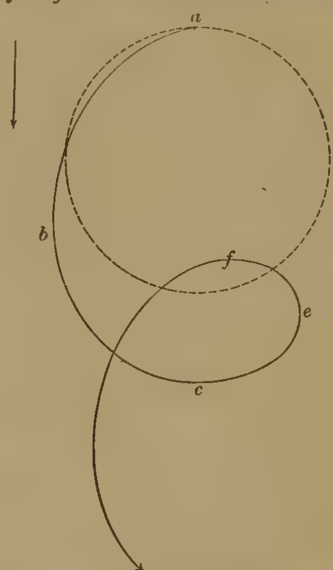



Fig. 2.

imply any impossibility, even including the resistance of the air to the advance. It is, however, important that the increment of velocity during the course *a b c* is equal to its diminution during the course *c e f*. Certainly the resistance of the air caused by the wind is greater during the latter part of the course than the former, but the distance during which it is working is shorter.

In which plane or planes the different parts of the course will pass depends upon the initial velocity and the changes

of relative velocity of the bird; naturally also upon the invariable quantities—the weight of the bird, the size and form of the wing-plane, so far as the latter has influence upon the resistance of the air to the advance. Now in *a* and *f* the relative velocity is the same as the absolute or minimal velocity. In *c* the relative velocity is also the same as the absolute velocity, but in *c* they are both greater than in *a* and *f*, as we have shown above. Thus the relative velocity has increased during the course *a b c*. From *a* to *b* no increment has occurred, but the contrary; so much the faster has it increased from *b* to *c*. During the course *c e* the relative velocity increases gradually, obtaining its maximum near *e*; whereas it gradually diminishes from *e* to *f*, so as to equal the initial velocity. Suppose, then, that the relative velocity diminishes somewhat during the course *a b*. This diminution, however, will be more than compensated for during the course *b c*, the relative velocity in *c* being greater than that in *a*.

During the whole course *c e f*, the relative velocity is greater than in *a* and *f*. Surely the supporting power of the current of air on the wings depends on the relative velocity. It increases with the relative velocity, if we suppose everything else to be unchanged, particularly the angle of the inclination of the wing-plane. If, therefore, the initial velocity in *a* by a certain pointing of the wing-plane is only just sufficient to maintain the bird at an unchanged level, the bird must, when describing the course *a* to *b*, gradually drop down. Even on the other side of *b* the sinking is continued until the relative velocity has increased so as to regain the same value as in *a*. From this point the course begins to rise and will continue rising until *f*, for to this point the relative velocity is greater than in *a*. Under such circumstances we cannot be astonished if the part *f* of the course will be in a higher plane than the part *a*, even if the resistance of the air to the advancing is infinitesimal.

Should the initial velocity in *a* be greater than what is required to maintain the bird on the same level, the bird would already have a rising course, and it might easily happen that no part of the course would be descending. However, the resistance of the air increases much faster than the relative velocity, and therefore the most available initial velocity will be different for different birds and for different force of wind. It is not as yet an easy matter to calculate the most favorable initial velocity to certain birds and to certain winds. But the discrepancies in the descriptions of the forms of the circles find, as may be easily seen, their explanations in supposing a different initial velocity. This is likely to be chosen differently by different birds, and may be different for the same bird according to different force of wind.

I am convinced that the bird always, even when soaring with the wind, has a greater velocity than the wind, and that thus during this part of the circle his speed is not hastened by the wind, but, on the contrary, he is here delayed, maybe less than in the other parts of the course. On the other hand, the velocity of the bird is augmented by the wind, as soon as the wind catches the bird from the side or obliquely from behind. This gain of velocity covers the loss caused by the resistance of the air to the advancing, and consequently allows the bird to maintain the necessary average velocity. It is less obvious, but nevertheless likely that the soaring bird, having gained the necessary velocity and having pointed his wing suitably, can without changing the form of his wings, incessantly continue the soaring as long as the force of the wind is unchanged.

Mr. Peal's explanation no doubt comes nearest the truth when he compares the soaring bird to a kite; we may consider the bird a kite, but the string which connects him with the earth is not fixed at a point of the surface of the earth, but the point of fastening moves with the wind, though it may be slower than the wind. It is the difference of velocity between the motion of the fastening-point and that of the air which affords the necessary power for the support and the rising of the bird.

Fig 1

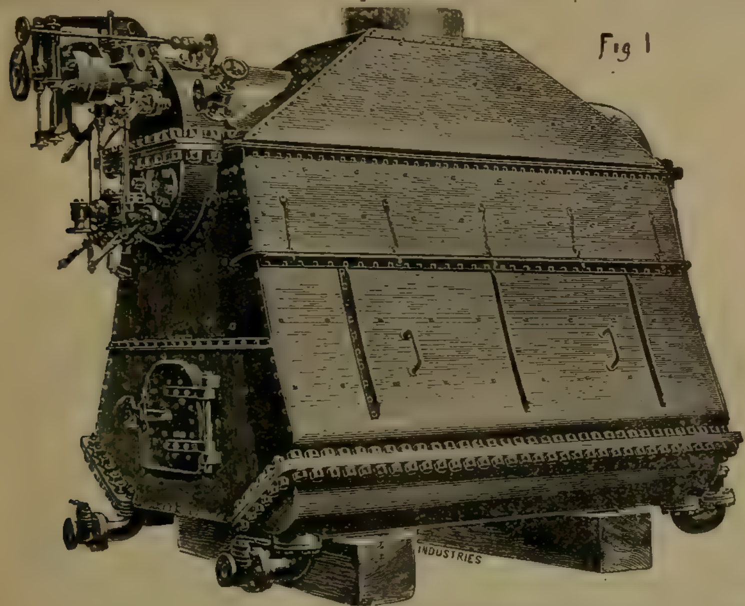
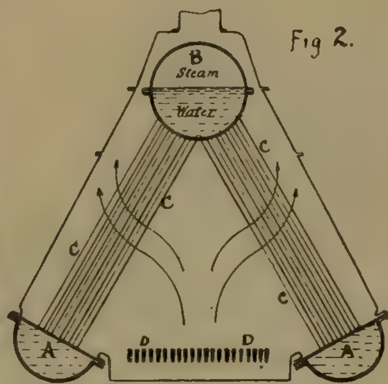



Fig 2.




THE YARROW TUBULOUS BOILER.

## BOILERS FOR HIGH PRESSURES.

Reference has been made in previous numbers of the Journal* to the use of tubulous and other forms of boilers for producing steam of the high pressure which marine engineers are now disposed to use as most economical. In the accompanying engravings two forms will be found, one of which has been reduced to practice, while the other has only been suggested.

The first is shown in figs. 1 and 2, and is a boiler made by Yarrow & Company, Poplar, England, for a torpedo-boat recently built by them for the Argentine Republic. Fig. 1 is a general view and fig. 2 is a cross-section through the center.

The general construction of the new boiler will be clear from these engravings. Two parallel longitudinal chambers, *AA*, the cross-section of each having the form of a sector of a circle, are united with a third, *B*—of cylindrical shape—by a great number of steel tubes, *CC*. The section thus resembles an inverted V with the cylindrical chamber at the apex, the tubes sloping downward at an angle of about 30°. The two lower chambers form water-pockets, and the water extends up to about the middle of the top chamber, the remaining space of the latter being filled with steam. The flat surfaces of the water-pockets

* In the Journal for July, 1890, page 319; for August, 1890, page 346; and for November, 1890, page 497.

form the tube-plates at one end of each series of tubes, the other ends being secured in the lower half of the cylindrical upper chamber. Each of the three chambers is about 6 ft. long, and the upper cylinder has a diameter of about 20 in.; each is made in two parts, with longitudinal flange joints. By removing the lower (circular) portions of the water-pockets *AA* and the upper part of the top cylinder *B* all the tubes are rendered accessible for cleaning or renewal. There is no direct connection between the lower chambers, and the whole system has complete freedom for expansion. The grate *D* occupies the space between the water-pockets, and the fire gases ascend between the tubes on either side, as indicated in the sketch, and over the top cylinder to the funnel. With the exception of the lower portion of the water-pockets, the whole is enclosed in a double wrought-iron casing filled with asbestos. All the tubes and chambers are of steel, and galvanized within and without. The feed-water is introduced from the front into the top cylinder near the middle of its length.

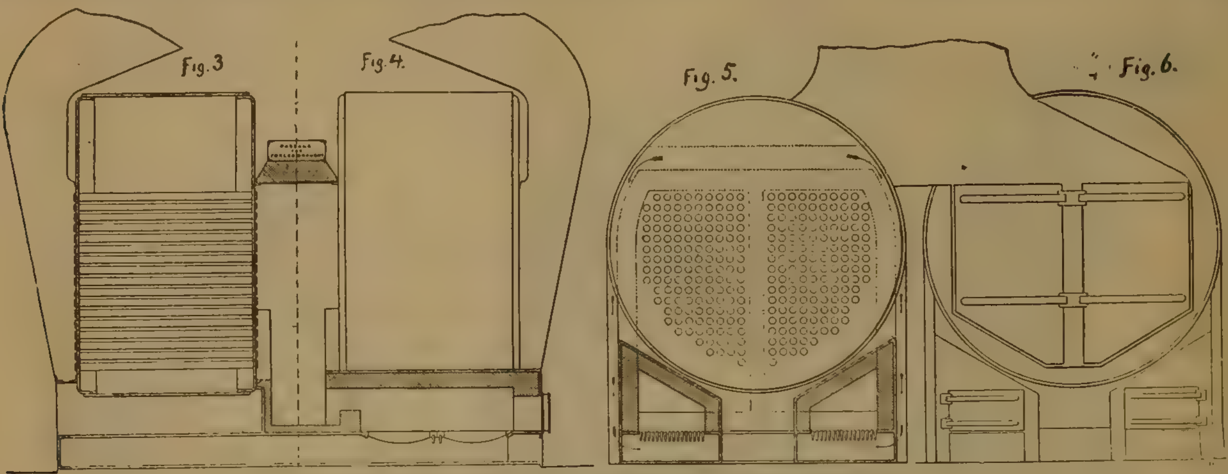
The circulation takes place upward through the hotter inner tubes—next the furnace—and downward through the outer tubes. Contrary to what might have been expected from the design, it is stated that no priming takes place.

Boilers of this kind have been in use for some time, and it is stated that no trouble has been experienced from leaking tube joints. As compared with a locomotive boiler suited for the same work, it is stated that the new generator is about 10 per cent. lighter, including coal and water. The cost is about the same in both cases.

The other boiler is shown in the second illustration, and is not of the tubulous type, but is a modification of the ordinary tubular marine boiler. In the engraving—for which we are indebted to *Industries*—fig. 3 is a section through the boiler; fig. 4 a section through the furnace; fig. 5 a transverse section and fig. 6 an end elevation. This form of boiler was recently suggested in a paper read before the Northeast Coast Institute of Shipbuilders & Engineers at Newcastle, England, and can best be described by a condensation of the paper.

To sum up his argument very briefly, the writer has endeavored to show that the economy of the three-crank triple-expansion over the two-crank compound has been mainly due to the increase of boiler pressure, and, to a small extent, to the increase of piston speed. That by increasing the boiler pressure to 250 lbs. per square inch a steam economy of, say, 15 per cent. can be obtained over the present three-crank triple. That an increase of piston speed, besides increasing the economy of steam, will also increase the weight economy, so that the piston speed should be increased up to the practicable limit. That the best type of engine to use this higher pressure, and best adapted to run at a high speed, is the four-crank four-cylinder engine, with unjacketed cylinders and separate steam and exhaust valves.

Passing on to the question of the type of boiler to be adopted, the writer is of opinion that a considerable departure from the present design of boiler is necessary, in order to make a satisfactory structure for 250 lbs. pressure. With this pressure difficulties will arise with the furnaces and the flat sides of the combustion chambers. To get over these difficulties the writer proposes to put the furnaces and combustion chambers outside the boiler altogether. The boiler then becomes a simple cylinder, the tubes running from end to end. As shown in figs. 3, 4, 5 and 6, the boilers are arranged back to back, with the combustion chambers between them. The furnaces and combustion chamber may be of cast or wrought iron, lined with firebrick. In order to keep down the grate surface, and thus economize space athwartships, it will be of advantage to use forced draft, and all the air on its way to the furnaces is made to pass over the top and sides of the combustion chamber, thus reducing to a minimum any loss from radiation.




PROPOSED HIGH-PRESSURE MARINE BOILER.

The advantages of a boiler of this type are obvious. It is perfectly suitable for a high pressure. There will be no straining from unequal temperatures. The cost of manufacture will be considerably less than that of the present type of boiler. For the same heating surface the space occupied is less; the boiler shown in figs. 3, 4, 5 and 6 is 10 ft. 6 in. diameter, and contains the same heating surface as a boiler of the present type, 13 ft. 6 in. diameter, the lengths in both cases being the same.

## A PARISIAN SUBWAY.

(From *Le Genie Civil.*)

THE Sceaux Railroad, built about 1848 on the plans of the Engineer Arnoux, was intended to show the possibility of using curves of very small radius. The principle of the system adopted consisted in the use of guiding rollers or wheels to keep the engines on the track, while the driving-wheels had no flanges.* Unfortunately this system was somewhat complicated for ordinary use and required a very wide guage, so that it did not come into general use.

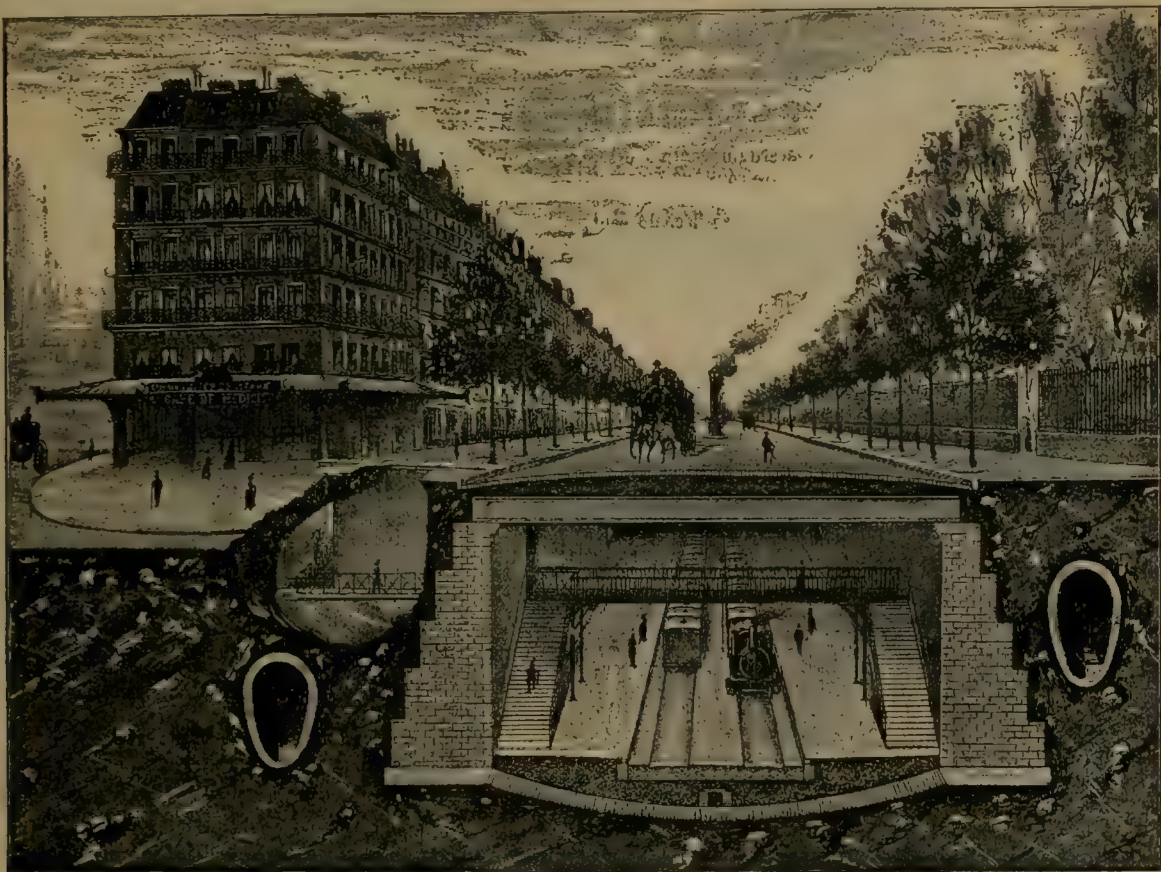
The Orleans Company recently bought this short road, and is now rebuilding it as an ordinary road and supplying it with equipment of the ordinary types. In connection with this rebuilding the road is being extended from the old terminus for some distance into the city. The new terminus is at the Rue Medicis, and the underground line by which that point is reached is to be extended across the city to the Orleans station on the Quai Maubert. The extension from the Rue Medicis is being surveyed. With a short addition outside of the city this will make a very convenient loop.

The extension now building is entirely underground. With the exception of a short distance under private property it runs under the street, most of the way under the Boulevard St. Michel. The line is double track, and for most of the distance has a grade of 2 per cent. Where it is sufficiently below the surface the tunnel is arched over with masonry; at other points there are retaining walls

* This system was described and illustrated in the JOURNAL for January last, page 46.

supporting iron girders which carry the street pavement. The latter is the method shown in the accompanying illustration, which is a section through the station at the Rue Medicis, the arrangement of which is very plainly shown. At this point the track is 32.8 ft. below the street level.

Ventilation of this subway is provided for by iron shafts or chimneys placed in the center of the boulevard at intervals of 328 ft. Some of these shafts are shown in the cut ; in a narrow or crowded street they would have to be differently placed. The station, it will be seen, has stairways leading to a passage under the sidewalk, the ticket-office and waiting room being in one of the buildings adjoining, so that there is no interference with the street itself. This subway has some points worth consideration here.



SUBWAY FOR THE SCEAUX RAILROAD IN PARIS.

## THE UNITED STATES NAVY.

THE accompanying illustrations, from the report of Chief Constructor T. D. Wilson, show two important ships now under construction for the Navy, about which very little has been said thus far.

### THE ARMORED CRUISER.

Armored Cruiser No. 2—the *Maine* is No. 1—which is under construction by the Cramp Company, in Philadelphia, and which will be named *New York*, will be a formidable vessel on account of her speed, her heavy battery and her powers of resistance. This ship will be 380 ft. 6½ in. in length on water line, 64 ft. beam, and will have a displacement of 8,150 tons, and a mean draft of 23 ft. 3½ in.

The main battery will consist of six 8-in. breech-loading rifles and twelve 4-in. rapid-fire guns ; the secondary battery of 12 smaller rapid-fire guns, four 37-mm. (1.46-in.) revolving canon, and four machine guns.

The hull is to be protected by a vertical armor-belt over the machinery space, and by a steel protective deck from 2½ to 6 in. thick, extending from stem to stern. Within the armor-belt and above the protective deck a coffer-dam 3⅓ ft. wide is to extend the whole length of the ship, and to be filled with some water-excluding material.

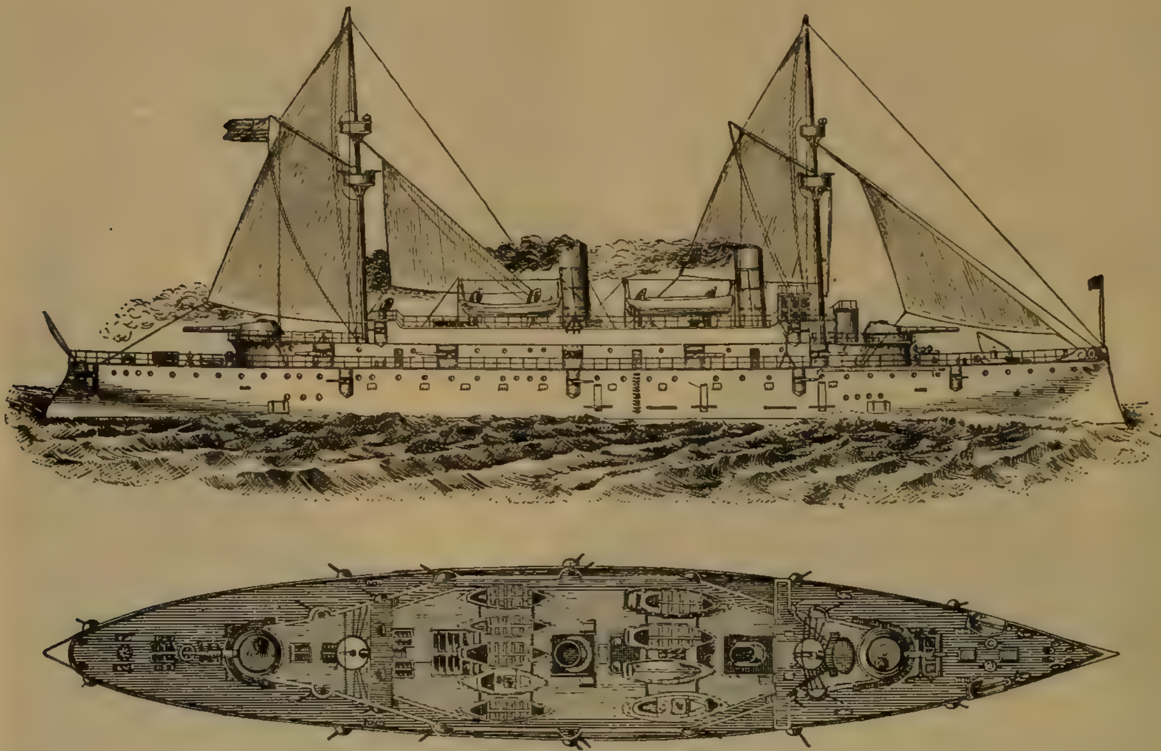
The 8-in. guns will be carried in barbettes with 10-in. armor, which will protect the carriages, platforms and loading positions ; over the guns will be shields 7 in. thick. The ammunition hoists and spaces below the heavy gun-mounts will have cone-shaped armor 5 in. thick. The 4-in. guns will have segmental shields of 4-in. plate, and the armor of the conning-tower will be 7½ in. thick.

This ship will have twin screws and will have four engines, two on each shaft, so arranged that the forward engines can be uncoupled and only the after engines used when cruising at slow speed. The engines will be of the vertical, inverted cylinder, direct-acting, triple-expansion type, the cylinders being 32 in., 46 in. and 70 in. in diameter, with 42-in. stroke. The valves will be all piston valves, driven by link motions. The bedplates will be of cast steel, and the engine framing will consist of cast steel inverted Y-frames, two to each cylinder. There will be one condenser and one auxiliary condenser to each engine, and the circulating and air pumps will be worked by independent engines.

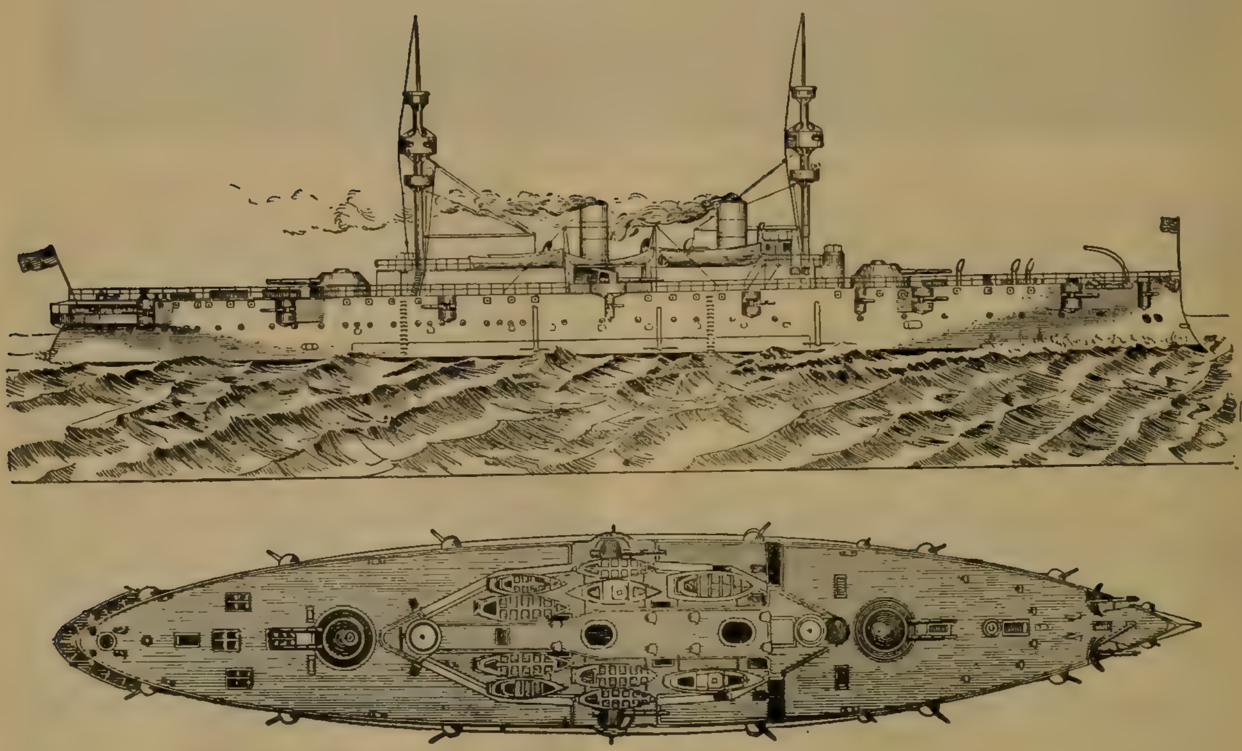
Steam will be furnished by six double-ended boilers, of the horizontal return fire-tube type, each 15 ft. 3 in. in diameter and 21 ft. 3 in. long, and each having eight corrugated furnace flues 3 ft. 3 in. inside diameter. There will be also two single-ended auxiliary boilers, each 10 ft. in diameter and 8 ft. 6 in. long, and each having two corrugated furnaces 2 ft. 9 in. inside diameters. All the boilers will be built for 160 lbs. working pressure.

For forced draft there will be six blowers—three to each fire-room—for the main boilers, and one blower to each auxiliary boiler.

It will be seen that this ship differs from all the other cruisers in having four engines, of which two will be sufficient for ordinary cruising, the others to be used only



CRUISER NO. 6 FOR THE UNITED STATES NAVY.



ARMORED CRUISER "NEW YORK," FOR THE UNITED STATES NAVY.

when high speed is required. These engines are expected to develop 16,000 H.P., and to propel the ship at a speed of 20 knots an hour.

The coal carried at normal displacement will be 500 tons; but the ship will be able to carry 1,500 tons altogether; this will give her a cruising endurance of 13,000 knots, at a speed of 10 knots an hour.

### THE NEW CRUISER.

Protected Cruiser No. 6, which the Union Iron Works are now building in San Francisco, is a twin-screw protected cruiser, of the following dimensions: Length on load water line, 340 ft.; extreme breadth, 53 ft.; mean draft, 21 ft. 6 in.; displacement at normal draft, 5,500 tons.

This ship has a protective deck $4\frac{3}{4}$ in. thick on the slopes and 2 in. on the flat over the machinery space; 3 in. on the slopes and 2 in. on the flat forward and abaft of it.

A belt of water-excluding material 33 in. thick, in cofferdams extending 4 ft. above and 4 ft. 5 in. below the load water line, extends the whole length of the vessel. Coal protection is afforded the machinery by the location of the bunkers along the side below the protective deck, and above that deck for the length of the engine and boiler space. The armored ammunition tubes are 3 in. thick, and the conning-tower 5 in. The hull plating is increased in thickness in the wake of all machine guns.

The main battery will consist of four 8-in. breech-loading rifles in barbette turrets 4 in. thick, and ten 5-in. rapid-fire guns protected by 4-in. segmental shields. The secondary battery will consist of fourteen 6-pounders, six 1-pounders and four Gatling guns. In each of the lower military tops will be mounted a 37-mm. Maxim gun and a 1-pounder Hotchkiss gun. The torpedo outfit will consist of six launching tubes for automobile torpedoes, one fixed at the stem, one at the stern, and two training tubes on each broadside.

There will be two vertical, direct-acting triple-expansion engines, one to each screw. The cylinders will be 42 in., 59 in. and 92 in. in diameter and 42-in. stroke.

Steam will be furnished by six boilers, two single-ended, each 15 ft. 3 in. in diameter and 10 ft. $11\frac{1}{4}$ in. long, with four corrugated tubular furnaces; the other four double-ended, 15 ft. 3 in. in diameter and 21 ft. 3 in. long, with light furnaces. They will carry 160 lbs. working pressure.

Working at full power and at about 128 revolutions per minute, the engines are expected to develop 13,500 H.P. and to give the ship a speed of $20\frac{1}{4}$ knots an hour.

The full coal capacity will be 1,300 tons. At maximum speed this supply will give a steaming radius of 2,192 knots. At a speed of 10 knots it will give a cruising endurance of 13,000 knots, or about 54 days' steaming.

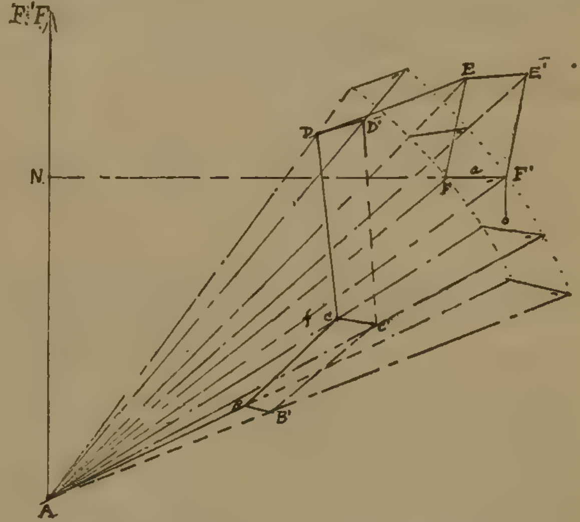
## ANSWER TO A PROBLEM IN SURVEYING.

PROBLEM:* *To correct a random traverse of several courses between two known points.*

Let $A, B, C, D, E, F$ represent a meander as originally run, of which $A$ is the known point of beginning and $F$ that of the terminus, and let $A', B', C', D', E', F'$ represent a random as run from the same field notes and terminating at $F'$. It is required to determine the courses and distances of the corrections $B'B$, $C'C$, $D'D$, etc., to the true angular points of the meander as originally surveyed.

| No. | Example. Course. | Dist. | Lat. +N. | −S. | Dep. +E. | −W. | Total. Lat. | Dep. | | Course. | Dist. | | Corrections. Course. | Dist. | How Found. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ch. | | | | | | | | | Ch. | | | Lks. | AF′F=OF′F−NAF′ =S. 39°54′ W. |
| 1 | N. 62° E. | 14.00 | 6.5726 | ..... | 12.3613 | ...... | + 6.5726 | +12.3613 | AB′ | N. 62° E. | 14.000 | B′B | N. 78° 6′ W. | 26.4 | AF′F+NAB′=101°54′ Sup.=N. 78°6′ W. |
| 2 | N. 43½° E. | 8.00 | 5.8030 | ..... | 5.5068 | ...... | +12.3756 | +17.8681 | AC′ | N. 55°18′ E. | 21.735 | C′C | N. 84°48′ W. | 40.9 | " +NAC′= 95°12′ " =N. 84°48′ W. |
| 3 | N. 5° W. | [illegible] | 11.9543 | ...... | ...... | 1.0459 | +24.3299 | +16.8222 | AD′ | N. 34°40′ E. | 29.579 | D′D | S. 74°34′ W. | 55.7 | " +NAD′=........... S. 74°34′ W. |
| 4 | N. 72½° E. | 10.25 | 3.0822 | ...... | 9.7756 | ..... | +27.4121 | +26.5978 | AE′ | N. 44°8′ E. | 38.195 | E′E | S. 84°2′ W. | 71.9 | " +NAE′=............S. 84°2′ W. |
| 5 | S. 12° W. | 6.43 | ....... | 6.2895 | ....... | 1.3360 | +21.1226 | +25.2610 | AF′ | N. 50°6′ E. | 32.928 | F′F | West. | 62.0 | " +NAF′=............ West. |
| 6 | West. | .62 | ....... | ..... | ....... | .62 | +21.1226 | +24.6410 | AF | N. 49°24′ E. | 32.455 | | | | |

Measure the course and distance of $F'F$. Draw $AF'$, $AF$ and $AN$ and $OF'$ as meridians. From $A$ as a center sweep arcs from $F'$ and $F$ to intersect radials drawn from $A$ through the points $B'$, $C'$, $D'$, etc. On each of




these radials form triangles equal to $AF'F$ and similarly situated, and draw $B'B$, $C'C$, etc., parallel to the sides opposite to $A$ of the corresponding triangles.

These lines will represent the courses and distances of the corrections. From the field notes find the total latitudes and departures of the points $B'$, $C'$, $D'$, $E'$, $F'$ and $F$. To determine the courses we have:

$$\text{Tangent of course} = \frac{\text{departure*}}{\text{latitude}}\ ; \quad \text{distance} = \frac{\text{latitude}}{\text{cos.course.}}$$

From the similarity of the several triangles we have:

$$AF' : F'F :: \left\{\begin{array}{l} AB' \\ AC' \\ AD' \\ AE' \end{array}\right\} : \left\{\begin{array}{l} B'B \\ C'C \\ D'D \\ E'E \end{array}\right\} = \text{the corrections in distance.}$$

The angle $AF'F$ will be the *sum* or *difference* of $OF'F$ and $NAF'$.

Set the instrument over $B'$, $C'$, $D'$ and $E'$, direct the telescope toward $A$, and turn off an angle equal to $AF'F$ to the *right* or *left*, as the case requires, and measure off the proper distances.

Or, the courses may be determined by combining the angles $NAB'$, $NAC'$, etc., with $AF'F$. Making $AF'$ the meridian, the course of $F'F$ will be known, to which add or subtract $NAB'$, $NAC'$, etc., as the case requires. The sum or difference when less than 90° will be the course, otherwise its supplement.

If it be desirable to re-run the meander from the corrected field notes as a test of accuracy, we have:

$NAF' \sim NAF$ = the correction in the courses and

$\dfrac{AF}{AF'}$ = the corrected length of the random chain.

* See JOURNAL for September, 1890, page 417; and for December, 1890, page 542. The problem was submitted by F. Hodgman, C.E., of Climax, Mich., and answered by him. The present answer is by Seth Pratt, C.E.

* The courses and distances are readily computed by logarithms,

Thus, $\left\{\begin{array}{l}\text{log. tan. of course,} = 10 + \text{log. Dep.} - \text{log. Lat.} \\ \text{log. Distance,} \quad = 10 + \text{log. Lat.} - \text{log. cos. of course.}\end{array}\right.$

With these corrections, the original meander may be rerun, and if the work be accurately done, the last course and distance will terminate at *F*.

## THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.



(*Continued from page* 78.)

### IX.—EXPLOSIVES.

The success achieved by mines and torpedoes during the War of the Rebellion awakened among all maritime powers a profound interest in these new agents of war. Gunpowder was at this time the only explosive employed in submarine warfare, but even of its capabilities when so used—the energy developed under the different conditions of submersion, position, nature of envelope, and methods of firing—but little was known.

At different times vessels had been blown up by way of experiment, but these trials gave little or no reliable data upon the points in question. The Confederates carried on some experiments in the James River to determine the amount of gunpowder charge, when placed as a ground mine upon river bottom, necessary to destroy a 1,000-ton vessel. From these experiments they deduced the general rule that in two fathoms of water 300 lbs. of gunpowder was required to destroy a vessel of this tonnage, which amount was gradually increased until in eight fathoms 2,400 lbs. was necessary. They further announced that where the bottom was rocky, 25 per cent. should be deducted from the amounts, and that one-third of these figures should be added for every 1,000 tons increase in a vessel's measurement.

To discover the laws governing subaqueous explosions was the problem presented to the engineer when the question of mine defense—of preparing and planting a system of mines—came to be solved. To this end a series of experiments were inaugurated in the United States soon after the close of the war. This was the most systematic and extended course of experiments ever undertaken in this country or, perhaps, in any other, to determine the laws governing the transmission of explosive energy through water, the explosive best adapted for submarine mining, together with all the attendant questions of mine-case, position, mooring, fuses, and manner of firing. It was carried out under the direction of General Abbott, in charge of the School of Submarine Mining, at Willet's Point, New York Harbor. Beginning in 1869, these experiments extended through the ten or twelve years following, and were so carefully made, and the details so minutely recorded, that the report upon the subject has become a classic.

In these experiments almost every kind of explosive then known was used—gunpowder of various grades, gun-cotton, nitro-glycerine, the dynamites, and explosive gelatine. The dynamometer used to measure the energy developed by these explosives was the crusher-gauge or pressure-piston, something after the kind employed in measuring the pressures in the powder chamber of a gun. The measure of the energy was the amount of compression of a small cylinder of lead placed under the base of a piston, the head of which, of given sectional area, was exposed to the action of the explosive charge. Two kinds of apparatus were employed in General Abbott's experiments—the one a stout ring of wrought iron, of diameters varying from 3 to 8 ft.; the other a crate of like material, 50 ft. × 10 ft. × 10 ft. In the center of each the charge of explosive was suspended, while the gauges, 6 in one case and 36 in the other, were rigidly secured in sockets about the circumference of the ring or at the angles of the crate; these were then suspended at different depths by suitable buoys, and the charge fired electrically.

Abroad the experiments have been largely made against targets representing approximately the shape and structural strength of the bottom of a war-ship, or against old hulls strengthened for the purpose, the gauges being secured against the side of the target or vessel.

From the data thus obtained formulas have been deduced into which all the conditions of the problem—strength of explosive, its distance, position, etc.—enter as factors. In the United States these have been obtained almost wholly from the pressure-gauge records, usually with small charges, while abroad, particularly in England, the actual destructive effect obtained with fairly large charges against a ship's bottom has been chiefly relied upon, the crusher-gauge records in these trials having never been published, and are supposed to be unreliable.

Of explosives in general, it may be said that they all belong to one of two classes—mechanical mixtures or chemical compounds. In the one case, as of gunpowder, the ingredients are mechanically mixed, and may be separated by mechanical means. The explosion is by the combustion of the individual grains. In the other class—represented by all the so-called high explosives—the composing elements are in chemical combination, and cannot be separated except through chemical change. Explosion is not by combustion; there is a simultaneous decomposition of the compound (detonation), and the initial pressure is the maximum one.

The introduction of the high explosives was an immense gain in the matter of submarine mining. This not only on account of the vastly greater explosive power they possess, but also from the fact that many of them are practically unaffected by the action of water. When the difficulty of excluding moisture from a submerged metal case is remembered, this latter gain will appear almost as great as the first.

Of the many kinds of high explosives employed in the experiments above referred to, but four or five have been found suitable for submarine work. These are gun-cotton, dynamite No. 1, explosive gelatine, blasting gelatine and forcite, or forcite gelatine. Of the others—dynamite Nos. 2 and 3, Hercules, Vulcan, and Atlas powders, tonite, etc.—the nitro-glycerine is mixed with the salts of sodium, potassium, magnesium or baryta, which are more or less deliquescent, and the compound is likely to deteriorate with exposure in a mine case.

The composition of these compounds is fairly well known. Dynamite No. 1, with its 75 per cent. of nitro-glycerine and 25 per cent. of absorbent earth, is usually taken as the standard in estimating the relative strength of various explosives. Explosive gelatine differs from blasting gelatine in the addition of a small amount of camphor. The constituents are of nitro-glycerine, nitro-cotton and camphor, 89; 7 and 4 per cent. respectively for the one, and of nitro-glycerine and nitro-cotton, 92, and 8 per cent. respectively for the other. Forcite gelatine, or forcite, has 95 per cent. nitro-glycerine and 5 per cent. unnitrated cellulose. The presence of the camphor in the explosive gelatine renders it practically insensible to shock. Under these conditions only a powerful primer will explode it. Rifle bullets fired into it at short range will not. It is believed to possess both mechanical and chemical stability, while its explosive power is greater than that of any other high explosive now in use.

As the result of General Abbott's experiments, he recommends that when it is necessary to use gunpowder for submarine mining only the finest grades should be used—sporting powder having 2½ times the strength of mortar powder when fired under water; that large charges are desirable; that strength of case is of great importance—a charge in a strong iron case giving three or four times the energy than if in a case of wood; that the nearer the case approaches a sphere in shape the better, and that an air space above the charge is advantageous in serving to direct the blast. He adds that, as regards the explosion of gunpowder, no great uniformity of results can be expected. These opinions are in the main concurred in by foreign engineers.

With regard to the high explosives he makes the following deductions: That only a moderate submergence is necessary to obtain the maximum force of explosion—a submersion of 4 ft. for a 100-lb. charge and 4 ft. per 100 lbs. additional for larger charges being sufficient to pro-

duce explosion of the first order; that a weak envelope gives better results than a strong one, and that with a proper quality of explosive no danger of deterioration after planting a mine need be apprehended, provided that the priming charge is kept dry by enclosing it in a separate envelope.

The following is given by General Abbott as the relative intensity of action, per unit of weight, of the various explosives when fired under water (dynamite No. 1 being taken as the standard):

| | |
|---|---|
| Dynamite No. 1 | 100 |
| Gun-cotton | 87 |
| Nitro-glycerine | 81 |
| Explosive gelatine | 117 |
| Gunpowder | 20 to 50 |

English writers on the subject give a different explosive value to some of these compounds. Colonel Bucknill gives the following:

| | |
|---|---|
| Dynamite No. 1 | 100 |
| Gun-cotton, dry | 100 |
| Explosive gelatine | 117 |
| Forcite gelatine | 133 |
| Blasting gelatine | 142 |
| Gunpowder | 25 |

From his experiments, General Abbott assumes that an instantaneous mean pressure of 6,500 lbs. per square inch will give a fatal blow to a modern iron-clad. Colonel Bucknill, on the other hand, believes this to be inadequate, and places the pressure per sq. in. necessary to destroy at 12,000 lbs.

General Abbott gives the following as the horizontal and vertical distances, in feet, at which the various explosives will destroy a modern iron clad, calculating 6,500 lbs. per sq. in. as necessary for this purpose:

| | 100 lbs. | | 500 lbs. | |
|---|---|---|---|---|
| | Hor. | Vert. | Hor. | Vert. |
| Dynamite No. 1 | 16.3 | 18.6 | 35.0 | 40.0 |
| Gun-cotton | 14.7 | 17.3 | 31.7 | 37.3 |
| Explosive gelatine | 18.2 | 20.3 | 39.1 | 43.7 |
| Gunpowder (sporting) | 3.3 | 3.3 | 19.5 | 19.5 |

Colonel Bucknell, from the *Oberon* and other experiments, gives the following as the charges and distances necessary to destroy a first-class war-ship with double bottom, assuming 12,000 lbs. per sq. in. pressure as being required:

| Distance in Feet. | [illegible] | 10 | 20 | 50 |
|---|---|---|---|---|
| Explosive. | lbs. | lbs. | lbs. | lbs. |
| Blasting gelatine. | 23.5 | 75 | 177 | 465 |
| Forcite " | 25 | [illegible] | 188 | 496 |
| Dynamite & Gun-cotton | [illegible] | 107 | 251 | 660 |
| Gunpowder | 132 | 428 | 1,004 | 2,640 |

He also gives the following as showing the wide difference in results obtained in working out tables of destructive charges of blasting gelatine and dynamite, with General Abbott's formula and his own:

| Distance in Feet. | 5 | | 10 | | 20 | | 40 | |
|---|---|---|---|---|---|---|---|---|
| Explosive. | Gelatine. | Dynamite. | Gelatine. | Dynamite. | Gelatine. | Dynamite. | Gelatine. | Dynamite. |
| | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| Abbott | 4 | 7½ | 17 | 32 | 67 | 127 | 311 | 581 |
| Bucknell | 23½ | 33 | 75 | 107 | 177 | 251 | 369 | 525 |

It would not be safe to predict that the explosives above mentioned will hold the field indefinitely against the host of new compounds that have been brought forward for recognition during the last half dozen years—bellite, hellhoffite, emmensite, melinite, etc.—and for some of which phenomenal explosive energy is claimed, but which remains to be confirmed by thorough and systematic experiment. The wonderful force claimed for the "terrible" French melinite is remembered. Recent experiments indicate that it is about equal to nitro-glycerine in explosive power.

In the English service gun-cotton has been adopted for submarine mining. In our own dynamite, which was at first adopted, is giving place to explosive gelatine. The French propose using melinite. One advantage claimed for dynamite is that it has become an article of commerce, and could be procured in any required quantity upon the outbreak of hostilities, which does not hold good for any other high explosive used in submarine mining. The objections to keeping any large quantity of these compounds in store are evident.

X.—PLANTING THE MINES.

As preliminary to putting down a system of submarine mines, the points to be determined upon are as to the kind of mine to be employed—whether buoyant or ground; whether they shall be simple contact, electro-contact, or

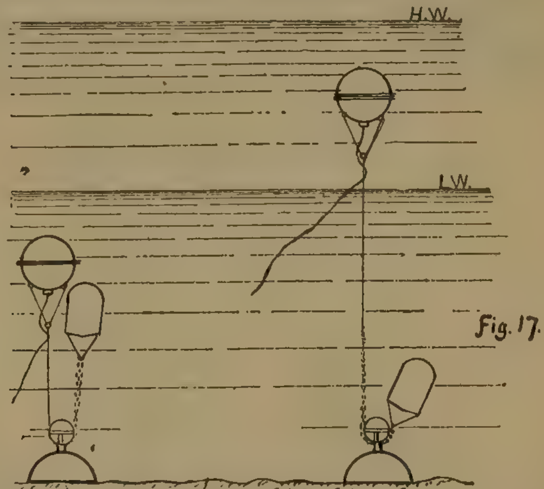


Fig. 17.

observation mines; whether anchored upon one or more lines, and the distance between the lines and the individual mines. As to the distance between the mines, the general rule that they shall be near enough together to make it impossible for a hostile vessel to cross the mine-field without coming within the destructive area of one or more of the mines, must be subordinated to the requirement that sufficient distance shall be maintained to prevent the destruction of adjoining mines by the explosion of one. A high explosive mine is much more liable to sympathetic explosion than one charged with gunpowder. Five hundred pound buoyant gunpowder mines may be anchored within 100 ft. of each other without danger from this cause, while those of blasting gelatine would require an interval of more than 400 ft.

After all the preliminary questions have been settled, the actual planting of a series of mines is by no means an easy task. The conditions to be satisfied are many and exacting. The more important of these conditions are that the individual mine shall maintain its position; that it shall remain at an effective depth at all stages of tide; that its explosion shall not endanger adjoining mines; that no entanglement of the cables of two or more mines shall be possible, and that it shall at all times preserve its invisibility. If the mines are to be fired by observation, the first of these conditions is of the greatest importance.

Where there is great rise and fall of tide the difficulty of maintaining a mine at a proper depth can well be understood. Anchored in the ordinary way, it would, at low water, either float upon the surface, or at high water be too deeply submerged to be effective. To overcome

this difficulty, Captain Ruck, of the Royal Engineers, has invented an ingenious method of mooring, as shown in fig. 17. To the mooring rope of the mine a length of chain is attached, whose links vary in size and weight. This passes through a pulley and is secured at the other end to a counterpoise of peculiar construction. As the tide rises the increased water-pressure upon the counterpoise reduces its buoyancy and the mine rises, pulling up the chain. As the tide falls, the weight of the chain and the increased buoyancy of the counterpoise pulls the mine down to its original position. The position of the mine is shown at high and low water.

In deep channels much used by friendly shipping it would be unadvisable to plant mines in advance of actual hostilities, unless some way were devised to protect them against constant collision with passing vessels. To meet this difficulty Colonel Bucknell proposes a dormant electro-contact mine—something after the pattern shown in fig. 18—that shall, in ordinary times, rest upon the bottom of the channel, but at the proper time can be made to rise

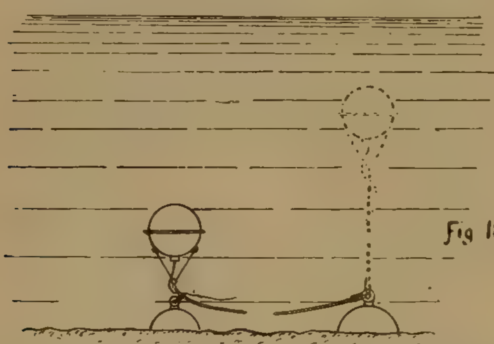


Fig 18.

toward the surface. This is accomplished by doubling down the mine rope and securing it near the mine case to its own or a second anchor, by an explosive link of brass or iron tubing, containing a small bursting charge and an electric fuse, which can be fired without disturbing the mine. When the link is exploded, the mine is released and rises to its proper position.

The size of mines to be employed and the manner of grouping vary with the different conditions of depth of water, width and character of the waterway to be defended. In our own service, where a considerable area is to be covered, the mines are arranged in grand groups of 21, subdivided into 7 groups of 3 each, as shown in fig. 19. This represents a system of electro-contact mines which may be fired at will or arranged to fire automatically upon contact. In the figure *a a a* are the triple junction-boxes; *b b b* single core cables; *c* the grand junction-box, and *d* the 7-cored cable leading to the firing station. As thus arranged, each core of the cable controls a group of three mines, and if fired from the shore station the group of three must be fired together. Any single mine may be discharged independently by contact with a passing vessel. The system might be so arranged as to have a separate wire for each mine, a triple cored cable connecting the group and the grand junction-boxes.

*Junction Boxes.*—These are water-tight boxes of cast iron, of any suitable shape, usually circular, as affording the greatest interior space, within which the connection between the mine wires and the multiple cable is made. They should be heavy enough to serve as their own anchor, be in some accessible place, but with no visible buoys to indicate their position to an enemy.

*Disconnectors.*—If a number of mines are connected up to the same main cable, and one of such a group be exploded, the bared end of the broken wire is likely to short circuit the main current, so that the others cannot be fired. To guard against this, a *disconnector*, or *cut-off*, is introduced into the circuit between each mine and the main cable, so arranged that upon the explosion of any one mine it shall be cut out from the main circuit. These are of

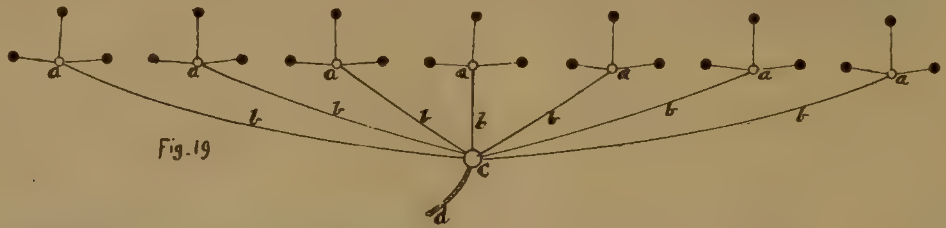



Fig. 19

a number of different patterns, the idea in them all being to "produce simultaneous rupture at two different points in the same circuit." The cut-off used in our own service is a low-tension fuse, identical in construction with that used to fire mines, except that the detonating cap is omitted, and the priming chamber closed with a plug. This fuse forms part of the electrical circuit leading to the mine, and is enclosed in a water-tight box, so that when ruptured the shore end of the cable becomes insulated. When the mine is exploded the bridges of both the mine and the cut-off fuse, being alike in all respects, are simultaneously ruptured—it being understood that the current must be strong enough to *fuse* the platinum bridges. In the English service one cut-off, much like our own, is used, and in another the wire is mechanically broken by using a bit of gun-cotton in the cut-off case. The cut-off may be placed in a water-tight case of its own and anchored near the junction-boxes, but a better arrangement is to place it

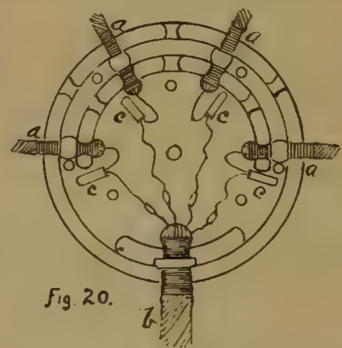



Fig. 20.

within the junction-box. Fig. 20 shows how this may be done. The cut represents a circular junction-box for seven cables, *a a a* being the individual mine cables, *b* the multiple cable leading to the firing station, and *c c c* the cut-off fuses. The manner of securing the cables is by means of a collar and turk's-head, as shown.

(TO BE CONTINUED.)

## THE CHIGNECTO SHIP RAILROAD.

THE ship railroad may be said to have its first germ in this country, in the inclined planes built many years ago on the Morris Canal in New Jersey, on which the canal boats were floated into a cage or crib running upon wheels and hoisted up the inclined plane to the higher level of the canal, the power used in most cases being the overflow of water from the upper level. This plan contained really the essential idea of the ship railroad, and in later times engineers have developed the idea and proposed its application in a number of cases. Notable among these was the plan of the late Captain Eads for a line across the Isthmus of Tehuantepec, which was so ably advocated by its distinguished author. Various circumstances have contributed to prevent the construction of any of the proposed lines, but the first ship railroad on a large scale is now approaching completion in Canada.

This railroad extends across the Chignecto Isthmus, which connects New Brunswick and Nova Scotia, and runs

from Amherst, which is at the head of Chignecto Bay, the western arm of the Bay of Fundy, to a point on Baie Verte, an arm of the Northumberland Straits. For many years some method of passing ships across this Isthmus has been talked about, and indeed some communication would naturally suggest itself to any one who studied the map. At its narrowest part it is only 17 miles across, whereas a vessel leaving Amherst for a point on the Straits or in Cape Breton or Prince Edward Island has to undertake a voyage of from 400 to 500 miles, passing the proverbially dangerous coast of Nova Scotia.

The first proposition was for a canal, but while the nature of the ground was not unfavorable, an obstacle was presented by the difference in tide levels. The Bay of Fundy is 21 ft. higher than Baie Verte at high tide and 18 ft. lower at low tide, the extreme variation in the tides at the head of the former being 36½ ft., and in the latter only 5½ ft. The great variation and the rapid rise and fall of the tides in the Bay of Fundy are well known, and would present a serious obstacle to the opening of the canal into that body of water.

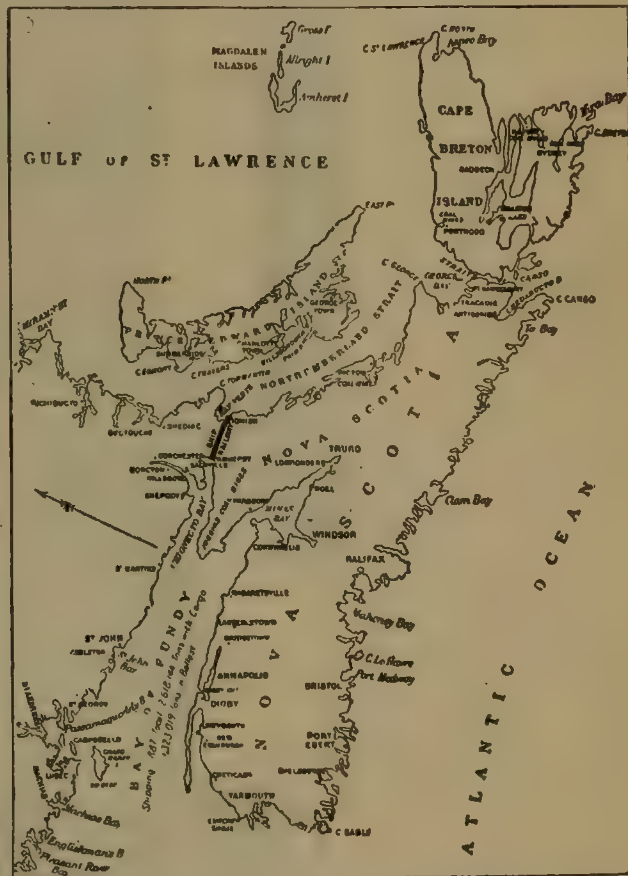
The construction of the Chignecto line is largely due to a Canadian engineer, Mr. Henry E. Ketchum, who first proposed the ship railroad in 1875, and who, by his persistent arguments in its favor, secured support from various influential bodies in Canada. In 1882 the scheme was brought before the Canadian Parliament and provision was then made for a subsidy, the amount of which was fixed at $170,300 yearly for 20 years. Mr. Ketchum's plans and estimates were submitted to the engineers employed by the Dominion of Canada, and later to Sir John Fowler and Sir Benjamin Baker, the well-known English engineers, and secured their approval, and to them in conjunction with Mr. Ketchum was finally committed the execution of the work. The land necessary for the railroad was given by the local authorities, and in 1886 a contract for the construction of the railroad was let to the firm of John G. Meiggs & Son, who began work in the autumn of 1888.

The general situation and relations of the ship railroad are shown in the accompanying sketch map. The traffic which it will carry will undoubtedly be large, and vessels of considerable size are expected to pass over it.

The distance from the head of the Cumberland Basin at Amherst to the terminus at Tidnish on Baie Verte is 17 miles. The ground is generally low, and on the final location it was found possible to make the railroad perfectly straight without any very heavy works. One cutting is required of no very great depth, but of considerable length, while the heaviest bridge work was at the crossing of the Tidnish River. The grades are not heavy, the road being for the most part level, while there is no grade exceeding 10 ft. to the mile. The first necessity in a railroad of this kind is to secure a solid roadbed, and the only difficulty here was in crossing the Tantramar Swamp, where rock filling was employed, and the line was brought up to a level of about 8 ft. above the surface, the amount of filling used being sufficient to leave no doubt that it entirely displaced the soft mud and rested upon solid bottom. At one other point a small swamp was crossed, and there the mud was excavated to hard bottom before filling in for the road-bed.

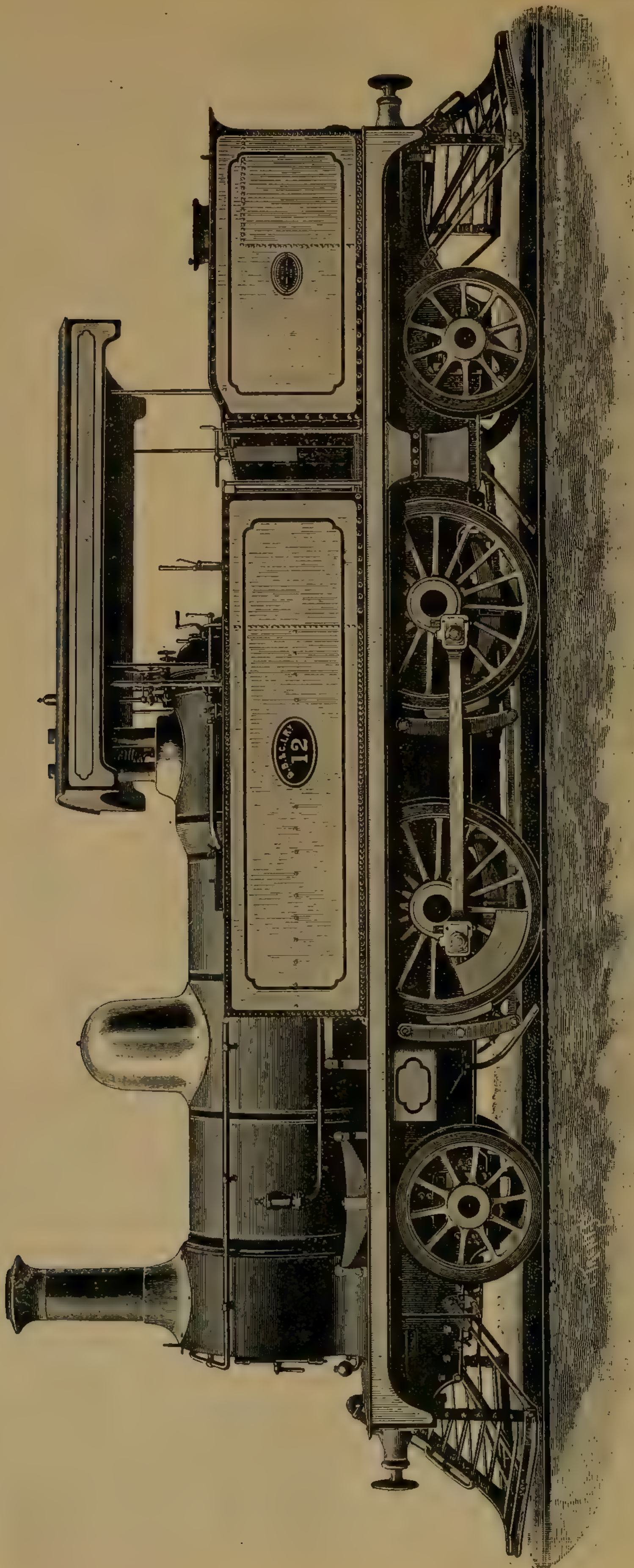
The railroad is constructed with the intention of carrying ships of 1,000 tons register or 2,000 tons displacement. The car or crib carrying the ships runs upon two tracks of the ordinary standard gauge, which are spaced 18 ft. center to center. The rails used for these tracks are probably the largest yet made, weighing 110 lbs. to the yard; they are 6½ in. in height and the joints and fastenings are made heavy in proportion. The ties are of pine 7 × 12 in. and 9 ft. long; at the joints ties 27 ft. in length are used, connecting all four rails. The track will be ballasted with stone throughout. The rails and all the track materials were supplied by Cammell & Company, of Sheffield, England. The car will require two locomotives to draw it at a speed of 10 miles an hour, which is considered the highest that could safely be adopted. Four locomotive tank engines of the Decapod pattern are being constructed for the railroad by the Canadian Locomotive Works at Kingston. In operation one of these locomotives will run upon each track, and when necessary two can be placed upon each.

The most important works in connection with a railroad of this kind are the docks at either end and the lifting apparatus, by which the ships are to be placed in the cribs. The receiving dock at the Amherst terminus is excavated from the land; at the Tidnish terminus it is built out into the sea. They are both of about the same dimensions, 500 ft. long, 300 ft. wide, and 40 ft. deep, capable of holding from 6 to 10 vessels, according to the size. The lifting docks, which connect with the receiving basins, are 250 ft. long and 60 ft. wide, and are constructed of solid masonry. The dimensions adopted are sufficient for the largest side-wheel steamers now in use on Northumberland Straits or on the Bay of Fundy. The seaward end of the receiving dock at Amherst will be




closed by gates in order to retain the water after the fall of the tide and to keep it at about the same level. Each of the lifting docks is provided with a ship lift or elevator worked by 20 hydraulic presses, 10 on each side, the powerful machinery for which was manufactured by the firm of Easton & Anderson, London, England.

The gridiron or crib, which is somewhat similar to a bridge floor and is really a movable section of the railroad, has placed upon it the cradle, which is carried upon trucks of peculiar design, especially prepared to stand the heavy weights required from them. There are, of course, two sets of these trucks intended to run upon the two tracks of the railroad. The gridiron with the cradle upon it being lowered to the bottom of the lifting dock, the vessel is floated in and placed precisely over the cradle, which is then raised to the level of the keel, where the supporting blocks are fitted accurately to the bottom. When it is thus in position, the hydraulic pumps will be started, and in about 10 minutes the gridiron will be lifted to the level of the track with which its own rails coincide. When it reaches this level it will be locked by proper fastenings to the track and to the sides of the dock, and the cradle drawn from the gridiron to the land by hydraulic capstans. The locomotives will be then attached to the car with the ship upon it, and ready to proceed to the other end of the



TANK LOCOMOTIVE FOR SUBURBAN PASSENGER TRAFFIC.

BOMBAY, BARODA & CENTRAL INDIA RAILROAD.

railroad. Here the processes will be exactly reversed. The car being run upon the gridiron, it will be then lowered to the bottom of the lifting dock and the ship floated off and out into the receiving dock.

A traverse table will be provided near the middle point of the line, so that two cars can pass and two ships can be upon the track at once. The cradles are so arranged that they can be fitted to carry two or three small vessels at one trip. These cradles or cars are now being manufactured in England at the works of Handyside & Company in Derby.

As already noted, the heaviest land works were the heavy cutting near Tidnish, which is now completed, and which was about two miles long, and the stone arch bridge over the Tidnish River. The road-bed having a uniform width of 40 ft., this cut required the removal of about 500,000 cub. yds. The other heavy land work was at the Tantramar Swamp, where a large amount of filling was required. The most important works in an engineering point of view are the docks. At the Tidnish end it was found necessary to construct a cofferdam for laying the masonry of the lifting dock. The outer or receiving dock at that point is formed of round timber cribs filled with rock and surrounded by piles of square timber, 12 × 12 in. in size. The upper part or bulkhead is of hewn timber filled in with stone. The basin within these docks is dredged out to a depth of 20 ft. at low water. The receiving dock here is an open basin, no gates being required, as at the Amherst end, on account of the comparatively slight variation of the tide. At the Amherst or Bay of Fundy end the receiving dock is excavated from the land, and is provided with masonry walls and lock gates, as already noted.

The present condition of the work promises an early completion. The Tidnish docks are nearly finished; the Amherst docks are well advanced; the tracks are laid the greater part of the distance across the Isthmus, and the heavy cutting and filling is all done. The contractors expect to have the entire work completed by October next, so that the first ship railroad on a large scale may be in operation before the close of the present year. Of its success as an engineering work there can be no doubt. Financially there are also fair prospects of its success. The whole cost of the work will be about $5,500,000; the operating expenses of the railroad are estimated at $150,000 a year. If only a small percentage of the Canadian coasting trade passes over the railroad, the returns, with a moderate toll, will be sufficient to pay the operating expenses and a reasonable interest on the cost, while the Dominion subsidy will be available for 20 years. Not only will the trade from St. John and the lower ports of the maritime provinces to the St. Lawrence pass this way, but it is thought that coal vessels from Cape Breton will find it to their advantage in many cases to take this route instead of the dangerous Atlantic voyage.

The prospective success and the approaching completion of this work has led to the formation of plans for others of the same kind. The most extensive scheme is for a ship railroad from a point on Georgian Bay to Lake Ontario, which will enable vessels to avoid the long detour through Lake Huron, Lake Erie, and the Welland Canal. This, however, seems to be still very much in the future, as the great cost of so long a railroad will prevent its construction, or at least postpone it for a long time to come.

## TANK LOCOMOTIVE FOR SUBURBAN TRAFFIC.

THE accompanying illustration, from the *Railway Engineer*, shows a tank engine designed by Mr. E. B. Carroll, Locomotive Superintendent of the Bombay, Baroda & Central India Railroad, for working the surburban traffic of that road out of Bombay, which is very heavy. The engines were built by the Vulcan Foundry Company, of Newton-le-Willows, England. The suburban trains usually consist of 12 cars, each 27 ft. in length, built on the English pattern, and are fitted with vacuum brakes. The distance run is 10 miles, with stations averaging three-quarters of a mile apart, so that an engine which can start quickly is needed for the work. The road is level, but has some sharp curves.

The pattern of engine adopted, as will be seen from the engraving, has four driving-wheels coupled, with inside cylinders, and two bearing axles, one under the smoke-box and the other under the rear tank. These bearing wheels are fitted with radial axle-boxes of the pattern used by Mr. Webb in England, giving the engine considerable flexibility. The cylinders, as before stated, are inside, with the steam-chests on the side, so that the two steam-chests come back to back in the center. Water is carried in two side tanks and in a rear tank, and fuel in the box over the tank on the back end of the frame. The frames are of the plate type, and are carried back behind the fire-box to support the tank. The engine is not provided with a close cab on account of the great heat of the climate, but with simply a roof supported by steel rods rising from the tanks.

The boiler, which is of steel, is 48 in. diameter of barrel, and has 168 tubes 2 in. in diameter and 10 ft. 3 in. long. The fire-box, which is of copper, is $49\frac{1}{2}$ in. long and $48\frac{1}{2}$ in. wide, and its extreme depth is 62 in. The heating surface is: Fire-box, 91.5 sq. ft.; tubes, 901.5 sq. ft.; total, 993 sq. ft. The grate area is 63.8 sq. ft. The fire-box is of copper, and the crown-sheet is held up by steel stays. The tubes are of brass. The gauge of the road is 5 ft. 6 in., this allowing an unusual width to the fire-box. There is one long-stroke pump and a Gresham & Craven injector.

The four driving-wheels are 60 in. in diameter, and the leading and trailing wheels are 42 in. The distance between centers of driving-wheels is 7 ft. 3 in., and the total wheel base of the engine is 20 ft. 9 in. The driving-axles have journals 7 in. diameter and 9 in. in length. The steel plate of the frames is 1 in. in thickness. The axle-boxes are of cast steel.

The cylinders are 17 in. in diameter by 24 in. stroke. The steam-ports are $1\frac{5}{8}$ in. × 14 in., and the exhaust ports 4 in. × 14 in. The valves have $1\frac{1}{8}$ in. lap and $4\frac{1}{16}$ in. maximum travel. The valve gear is of the Allan straight link type.

The side tanks hold 200 gals. each, and the end tank 400 gals.; the total amount of water carried is thus 800 gals., and the fuel-box will hold $2\frac{1}{2}$ tons of coal. The total weight of the engine in working order and with tanks full is 101,000 lbs., of which 55,800 lbs. are carried on the driving-wheels and 42,200 lbs. on the four bearing-wheels.

These engines, it is said, run very steadily, and have worked remarkably well for the peculiar traffic for which they were intended. It will be seen that brakes are fitted to the driving-wheels. The engines are fitted with a pilot at each end, and are not turned at the end of the run. In service they are kept pretty steadily at work, being allowed but little time between runs. The average coal consumption of one of them for nine months, with the train above noted, was 32 lbs. per mile.

## THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

(*Continued from page* 88.)

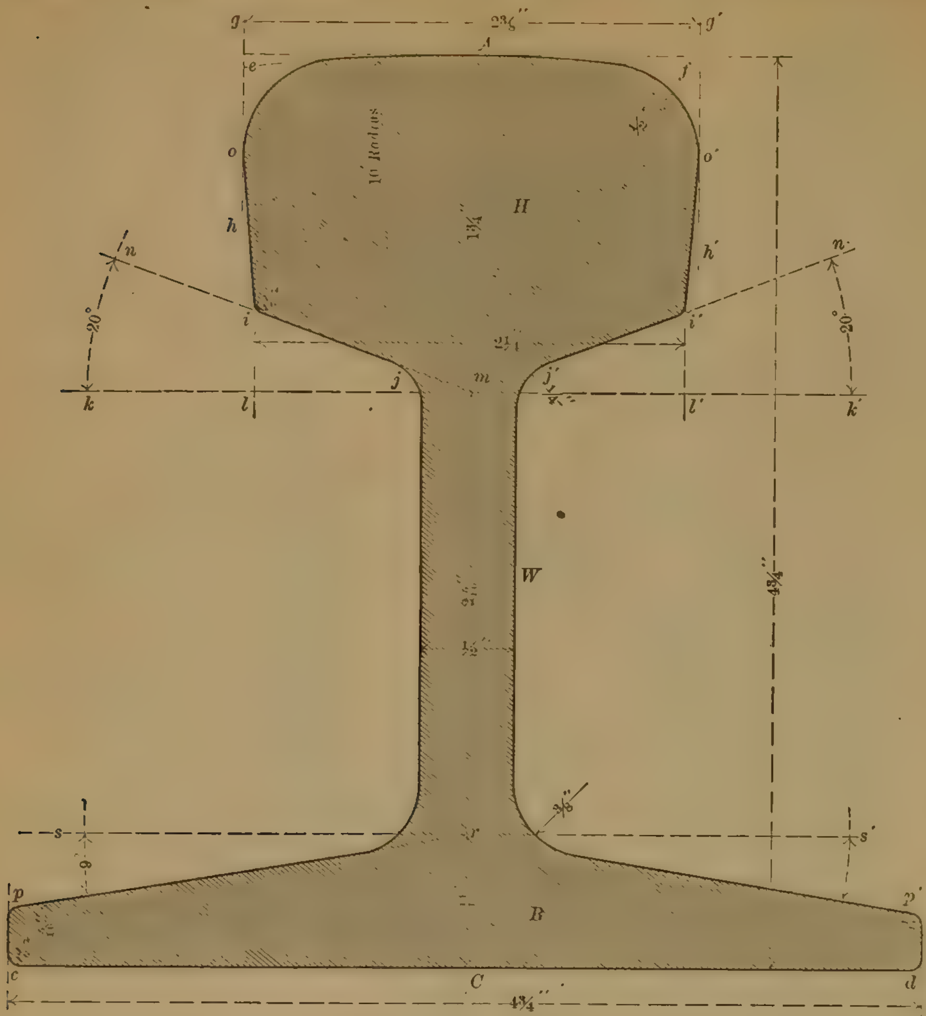
### CHAPTER VIII.

#### THE DELINEATION OF ANGLES.

THE methods of laying out angles were fully described in Chapter III. Some illustrations of the use of those methods will be given here.

Fig. 223 represents a section of a railroad rail drawn full size. In drawing this the first step is to lay down a vertical center line, $A\ B$. At any convenient point, as $B$, near the lower end of $A\ B$, draw a horizontal line $c\ d$, to represent the bottom of the rail. From the intersection $B$ of $A\ B$ with $c\ d$ lay off the width $c\ d$ of the base of the rail, and its height $B\ A$, each equal to $4\frac{5}{8}$ in. It will be noticed that the top of the rail head is curved, the curve being drawn with a radius of 10 in. With this radius find a center on the vertical center line $A\ B$ extended below $B$, at a distance of 10 in. from $A$, and draw the curve $e\ f$.

The width of the top of the head of the rail, it will be seen, is $2\frac{5}{8}$ in. Lay off half this dimension on each side of $A$, and draw vertical pencil lines $g\ h$ and $g'\ h'$. The curves of the two upper corners of the head are arcs of circles of $\frac{1}{2}$-in. radii. With this




RAIL SECTION, 72 LBS. PER YARD.
*Full Size.*
**Fig. 223.**

radius the curves should be drawn tangent to $e\ f$ and to $g\ h$ and $g'\ h'$.

It will also be seen that the lower portions $i\ j$ and $i'\ j'$ of the head are drawn at angles of 20° to the horizontal line $k\ l$, which intersects the vertical line $A\ B$ at $m$, and that the distance of $m$ from $A$ is $1\frac{3}{4}$ in. Therefore, from $A$ lay off the point $m$ on $A\ B$, and draw the horizontal line $k\ l$ through this point. Then, referring to fig. 41, take from it the radius $A\ c$, and from $m$ as a center draw with this radius indefinite arcs $k\ n$ and $k'\ n'$. Having done this, take from fig. 41, with a pair of dividers, from $c$, on the circumference of the large circle, the distance to the point marked 20, or 20° of the circumference, and lay this off from $k$ and $k'$ to $n$ and $n'$. Then, from $m$ draw $m\ n$ and $m\ n'$. These lines will then be at an angle of 20° with $k\ k'$.

The sides of the head of the rail, it will be seen, slope inward from the top, so that the lower part of the head is narrower than the top. The width below is $2\frac{1}{4}$ in. This may be laid off from $m$ on $k\ k'$, and vertical lines $l\ i$ and $l'\ i'$ should be drawn through $l$ and $l'$. As the lower corners of the rail are rounded with curves of $\frac{1}{16}$ in., these should be drawn tangent to $i\ l$ and $n\ m$ and to $i'\ l'$ and $m\ n'$. The curves of the upper corners and those of the lower ones may then be united by the lines $o\ i$ and $o'\ i'$.

The *stem*, or *web*, $W$ of the rail is $\frac{1}{2}$ in. thick, and is represented by two vertical straight lines.

The top $p\ r$ and $p\ r'$, it will also be seen, is drawn at an angle of 9° to the horizontal line $s\ s'$ which intersects $A\ C$ at $r$, which is $\frac{11}{16}$ in. above the bottom of the base at $C$. These angulated lines may be drawn in the manner already described. The lower portion of the head is then united to the web with curves drawn with $\frac{1}{2}$ in. radius, and the top of the base is also united to the stem or web with curves drawn with $\frac{3}{8}$ in. radius. Rounding the outer corners of the base with curves drawn with $\frac{1}{16}$ in. radius completes the section.

In ruling the section of the rail, the lines should be drawn further apart than they are shown in the engraving; if drawn in this way it will require less time and skill to do it neatly, and will answer the purpose equally well, or better than the fine ruling will.

### PLOTTING SURVEYS.

In measuring the surface of ground the direction of the lines are always ascertained by means of a surveyor's compass. Lines running north and south are assumed, and such lines are called *meridians.* A line traced or measured on the ground is called a *course;* and the angle which this line makes with the meridian passing through the point of beginning is called the bearing. Thus, let the line $N\ S$, fig. 224, represent a meridian. Then, if we start from the point $A$ and measure in the direction $A\ B$, the line $A\ B$ is the *course*, and the angle $N\ A\ B$ is the *bearing*.

When the course, like $A\ B$, falls between the north and east points, the bearing is read, *north* 46° *east*, and is written, *N.* 46° *E.* That implies that the direction of the line from its point of beginning is northward and eastward, and that the angle $N\ A\ B = 46°$.

When the course, like $A\ C$, falls between the north and west points, the bearing is read, *north* 30° *west*, and is written, *N.* 30° *W.* This implies that its direction is northward and westward, and the angle $N\ A\ C = 30°$. When the course, like $A\ F$, falls between the south and east points, the bearing is read, *south* 70° *east*, which is written, *S.* 70° *E.*, and the angle $S\ A\ F = 70°$. When the course, like $A\ D$, falls between the south and west points, the bearing is read, *south* 60°

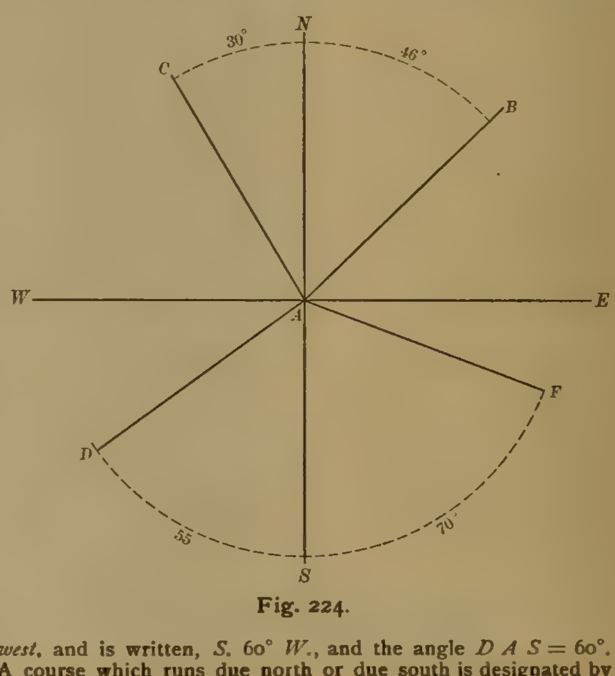



**Fig. 224.**

*west*, and is written, *S.* 60° *W.*, and the angle $D\ A\ S = 60°$. A course which runs due north or due south is designated by

No. 1.—ROMAN.

A B C D E F G H I J K L M N
O P Q R S T U V W X Y Z &

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n o p q r
s t u v w x y z

No. 2.—TITLE.

A B C D E F G H I J K
L M N O P Q R S T U
V W X Y Z &

1 2 3 4 5 6 7 8 9 0

No. 3.—CELTIC.

A B C D E F G H I J K L
M N O P Q R S T U
V W X Y Z &
1 2 3 4 5 6 7 8 9 0

No. 4.—ITALIC.

*A B C D E F G H I J K L M N*
*O P Q R S T U V W X Y Z &*

*a b c d e f g h i j k l m n o p q r*
*s t u v w x y z*

No. 5.—GOTHIC.

A B C D E F G H I J K L
M N O P Q R S T U
V W X Y Z &

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n o
p q r s t u v w x y z

No. 6.—GOTHIC EXTENDED.

A B C D E F G H I J
K L M N O P Q R S
T U V W X Y Z &

the letter *N.* or *S.*, and one which runs due east or due west by the letter *E.* or *W.**

Let it be supposed now that we have a piece of land bounded and described as follows: Beginning at a stone for a corner, at 1, fig. 225, N. 31½° W., ten chains to a white oak tree, at 2; thence N. 62¾° E. 9.25 chains to a post; thence S. 36° E. 7.60 chains to a boundary stone at 3; and thence S. 45½° W. 10.40 chains to the place of beginning.

To make a plan of such a piece of land, or to *plot* it, as it is

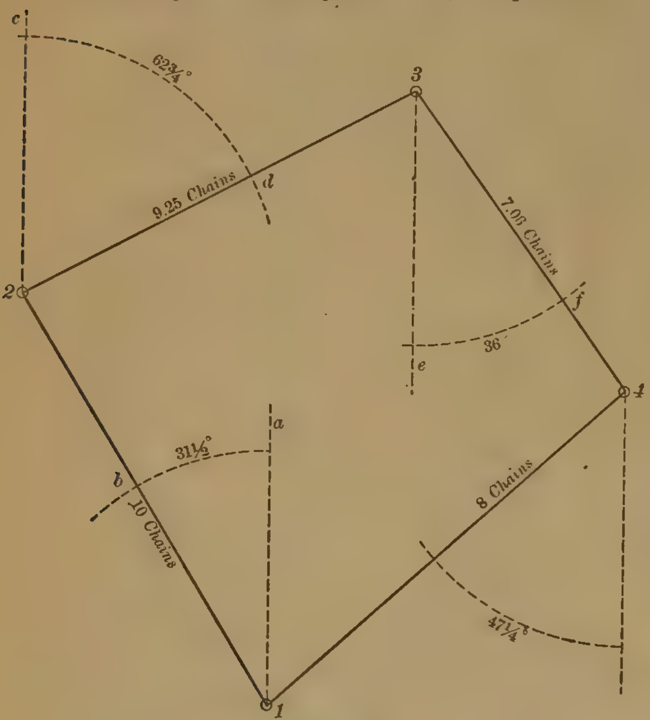



Fig. 225.

called, first fix upon a scale—in the present instance ¼ in. = 1 chain. Then, through the point of beginning 1, draw a straight line *a* 1, to represent a meridian, or north and south line. From 1 lay off the angle *a* 1 *b* = the bearing on the left or west side of the meridian, above or north of 1, and measure off the first distance or course 1 2 equal to 10 chains on the line 1 *b* extended. Then draw another line or meridian 2 *c* through 2 and parallel to 1 *a*, and lay off the angle *c* 2 *d* north and east of 2 *c* = 62¾° = the second bearing, and measure off on 2 *d* extended the distance 2 3, 9.25 chains = the second course. Through 3 draw the meridian 3 *e* and proceed as before, noting that as the third bearing is *S.* and *E.*, that the angle *e* 3 *f* must be laid off below or south, and on the right-hand side or east of 3. The meridians must, of course, all be parallel to each other. Ordinarily, lines drawn perpendicular to the lower edge of the paper are the most convenient for the representation of meridians, but this is not essential.

When the last course, 4 1, is drawn, it should join the first and last stations 4 and 1. If it does not, and there is an open space between 1 and the extremity of the last course, it shows that there is either an error in the measurement of the land or in the drawing. Methods of correcting errors in the measurement of land are given in the books on surveying, to which those in search of further information on the subject are referred.

## CHAPTER IX.

### TITLES AND LETTERING.

A drawing should *always* have a descriptive title, the scale to which it is made and the date when it was finished distinctly inscribed on it. Each of these is important, although at the time the drawing is completed it may not appear so. The student will realize this if he has occasion to make use of old drawings, decipher their meaning or ascertain what they represent. When they have just been completed, all this information is fresh in the minds of those interested, or can be easily learned; but in time all recollection of them will have faded away or literally be buried with those who were possessed of the knowledge. It is often of the utmost importance to know whether a drawing represents a part of one machine or a part of another. If no dimensions are given, it is difficult, and sometimes impossible, to ascertain the scale to which a drawing was made, and often the date is of vital importance. This is especially the case with patent drawings. A draftsman should make it a rule never to allow a drawing to leave his hands without putting a title, the scale, and the date on it. If he is too busy to give more than a very little time to it, he should write it on with a pen or pencil hastily. This may be of great importance in the future. The style of the lettering is very seldom a matter of much consequence, but that the exact object represented, the scale, and date should be known is often of vital importance.

With reference to the subject-matter of titles, no general directions can be given. In this the student must be guided by his own common sense and perspicuity. The title of a drawing should always be capable of conveying to a person without more than a general knowledge of it exactly what it represents. The date and scale are usually given on a line below the title.

As remarked by a writer* on this subject, the plainer the lettering on a mechanical drawing the better. Most young draftsmen, in the exuberance of youth, are ambitious to add highly ornate titles to their finished drawings. This is a juvenile malady which it is perhaps not always best to check, and which leaves no ill effects after, but is sure to disappear in the companionship of hard work. While elaborate lettering is not to be recommended, it is also true that if it is carelessly or awkwardly done it detracts very much from the merits of a good drawing.

As mechanical drawings are constructed in accordance with strict geometrical rules, the lettering on them should have a similar character. For this reason what are known as Gothic letters are the most suitable, of which examples are given in the sample alphabets herewith. The style which can be done most quickly and easily is what is known as "*slant Gothic*," No. 8, For outline drawings, outline letters, similar to No. 7, look well, as they are less conspicuous than those which are drawn in solid black. Italic letters are more easily drawn with an ordinary writing pen, if a person once acquires the skill to make them neatly. The "bulletin" letters, No. 10, can also be made quickly.

In lettering, rules will be found to be of little use. Neat work is chiefly dependent upon skill, as ordinary writing is, and that, in turn, is usually the result of practice, although natural aptitude has much to do with it. It has been remarked that skill in lettering and a good ear for music are usually found in the same person.

If lettering is to be done neatly two parallel pencil lines

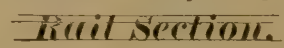



Fig. 226.


should be ruled to define the height of the large letters, and if small ones are used, another line should be drawn between the two for their height, as in fig. 226. If Gothic letters are used, or any other style the outlines of which are straight lines, which can be drawn with a ruling pen, they should be sketched in with a pencil, the spacing and proportions of the letters being done with the eye. The outlines, or those consisting of straight lines, can then be drawn with a ruling pen. Italic and most other styles of letters excepting Gothic must be drawn with an ordinary writing pen, although it is often well to sketch them in first with a pencil, so as to get their spacing and position right.

It usually happens that a title must be placed in a central position on a drawing, and that it will look much better if its beginning and ending are at equal distances from a center line. To accomplish this, count all the letters in the title and count the spaces between the words as so many letters. Then ascertain the middle letter or space, and, beginning with that, place it on the center line, or, if there are an even number of letters, place the middle space between the letters on the center and sketch in the title with a pencil from the middle to the end. Then lay off the distance from the middle to the end on the left side of the center, and, beginning from the point thus laid off, sketch in the first part of the title. The scale and the date and if there is anything else included in the title should be laid off in a similar way, so as to be symmetrical. When this is done, the lettering may be finished with ink. For fine lettering, Gillott's No. 303 Extra Fine writing pens are very good.

To become skillful in lettering, the student must practise the art. He should take a sheet of paper, and, after ruling it so as to give the size of the letters, imitate some or all of the alphabets given herewith. In this, as in many other things, the old adage, "if at first you don't succeed, try, try again," is the best instruction.

* John Maxton, engineer, in "The Workman's Manual of Engineering Drawing."

* Davies's "Surveying."

No. 7.—GOTHIC CONDENSED.

A B C D E F G H I J K L M N O P
Q R S T U V W X Y Z &

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n o p q r s
t u v w x y z

No. 8.—GOTHIC ITALIC.

*A B C D E F G H I J K L M N O P Q R S T*
*U V W X Y Z &*

*1 2 3 4 5 6 7 8 9 0*

*a b c d e f g h i j k l m n o p q r s t u v w*
*x y z*

No. 9. GOTHIC SHADED.

A B C D E F G H I J K L M N
O P Q R S T U V W X Y Z &

No. 10.—BULLETIN.

A B C D E F G H I J K
L M N O P Q R S T
U V W X Y Z

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n
o p q r s t u v w x z

No. 11.—ARABESQUE.

A B C D E F G H I J K L M N O P
Q R S T U V W X Y Z &

1 2 3 4 5 6 7 8 9 0

a b c d e f g h i j k l m n o p q r s t u v w
x y z

A number of alphabets are given herewith ; space prevents our giving more in this number, but others will be given hereafter.

(TO BE CONTINUED.)

### Tests of Varnish.

(Paper read before the Master Car & Locomotive Painters' Association, by Mr. A. T. Schroeder, Master Car Painter, Chicago, Milwaukee & St. Paul Railroad.)

MR. J. N. BARR, our Superintendent of Motive Power, being of the conviction that it was the only way to arrive at conclusions in adopting standard material, instructed me to test all of our paint material, and, as varnish is one of the most important materials, it was concluded, in order to obtain the relative merits of the various varnishes, to finish every car, wherever practicable, with two varnishes ; that is to say, one-half of the car with one brand, the other half with another brand, in such a way that every long side of a car should show the two varnishes as they meet in the center. Thus it would be plainly demonstrated by the material itself which of the two, in a certain length of time, would prove to be preferable.

From the fall of 1886 to the close of 1889 more than 200 cars were finished in this way, and altogether 17 different brands applied. It was clearly demonstrated that several of these, to put it mildly, were not at all adapted for that purpose, and they consequently had to be discarded ; finally the brands were reduced to a limited number, and one of these, which had proved so far to be the best one in all respects, was put in competition with all the remaining ones. Up to now we have not arrived at a final conclusion, because of the many circumstances to be taken into consideration, but during my experience in testing varnish in this manner facts were revealed of which I never heretofore dreamed.

Our standard for sleeping, dining and parlor cars is Pullman color ; the ornamentation applied on the flat paint and the car then finished with one coat of rubbing and two coats of finishing varnish. Passenger, baggage and other cars are painted yellow, last coat varnish color, of the formula of 1 lb. paste body color, 1½ lbs. rubbing varnish and 2 oz. turpentine ; then ornamented and finished with two coats finishing varnish.

At the suggestion of Mr. Barr we took a few cars and varnished them with one brand for the whole car, but used for one-half of the car one coat of rubbing and one coat of finishing varnish, and for the other half two coats of finishing varnish, in order to ascertain which process would give the best results. This was done accordingly. After a very short time the difference was so manifest that the one-half on which rubbing varnish had been used lost so much of its luster that it showed a marked dividing line in the center of the car, and after a few months longer the contrast had so increased as to make it appear as though originally only one-half of the car had been varnished. Naturally such a car was immediately called in for revarnishing. On other cars which had to stay on the road from 16 to 20 months such difference could not be distinguished, as all luster had disappeared, yet I observed that the half with the rubbing varnish over the gold was in a more advanced state of decay than on the other half, where two coats of wearing body varnish had been applied. Furthermore, a difference in favor of the latter was found when I applied the so-called oil test, of which I will make mention later on.

Now about these cars on which two brands were used, each car finished with two coats of wearing body varnish. In regard to the luster it was very difficult to discover any difference, whereas on the yellow car it was found, after careful investigation, that some brands were superior in transparency. Yet I think this is only a matter of secondary consideration, as durability is certainly the most important object.

The oil test is as follows : After 10 months of service a car arrives at the shop ; both varnishes have the same appearance and surface, and no difference in the two varnishes can be noted. I then have a vial filled with half-and-half boiled and raw linseed-oil, and a 2-in. long round wire nail, driven into the cork and extending into the oil. With this nail I take out a drop of oil and apply it on the varnish, making drops of various sizes, so that I may be able to note how much, if any, of this oil will penetrate into, or spread out on, the varnish. After four or five hours I find that on the one varnish the oil has entirely penetrated and scarcely left a visible trace, whereas on the other varnish the oil remains as applied, thus showing that no absorption whatsoever has taken place. Which of the two varnishes should have the preference ? Which one will protect paint and wood best I need not say.

On another car, one-half is in best condition, paint as well as varnish ; but on the other half long cracks, running with the grain of the wood on the panels, draw through them, which, upon examination, are found to extend deep into the paint. Is the paint responsible for the cracking ? I cannot believe so. The whole car was painted with the same paint at the same time and under like conditions. But, supposing that the whole car had been varnished with that one brand, would not the painter have to carry the blame ? How could he prove the contrary ? Who would believe him ?

Of course, by testing varnish in this manner, many cars were utterly spoiled, and we had to remedy the evil as quickly as possible. It would be useless to recite the results of all of these various cases ; suffice it to say, that it has brought to light many interesting facts, and although I was not able to examine all of these 200 cars, a great number of them enabled me, upon examination, to form a correct opinion as to the merits of the material.

### Lake Shipbuilding.

(From the Cleveland *Marine Review.*)

WITHIN the last five years the tonnage of the lakes has been more than doubled, and it is interesting to note this wonderful growth in new ships from reliable sources. In the spring of 1886 began an era of profitable freights and with it the displacement of the small wooden boats by big steel carriers. As a result ship-building has been carried on to such an extent as to cause some fears of overproduction. The new tonnage to be floated next spring, however, will fall but short of previous years, and this is saying a great deal when the figures are considered. In a synopsis of the forthcoming report of William W. Bates, Commissioner of Navigation, shipbuilding returns for three years past are given, and by reference to former reports the following table, showing the work of five years, is secured :

| | No. of Boats. | Net Tonnage. |
|---|---|---|
| 1886 | 85 | 20,400.54 |
| 1887 | 152 | 56,488.32 |
| 1888 | 222 | 101,102.87 |
| 1889 | 225 | 107,080.30 |
| 1890 | 218 | 108,525.00 |
| Total | 902 | 393,597.03 |

The following table, from the same source, shows the tonnage of vessels built in the United States from 1857 to 1890, and it is remarkable that the increase on the lakes in the past five years—393,597 tons—is equal to that of 12 years previous :

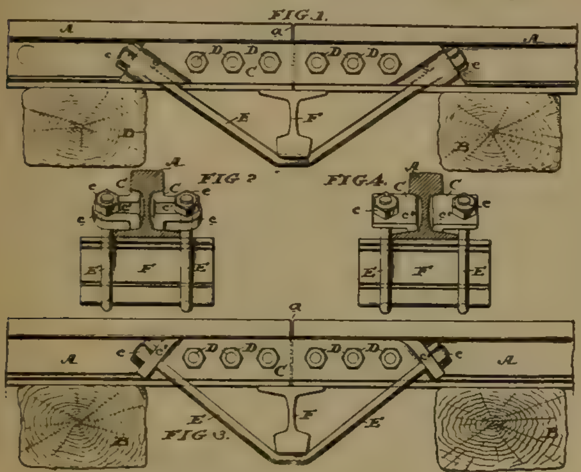
| YEAR ENDING JUNE 30. | On the Great Lakes. | On the entire Seaboard. | On the Mississippi River and its Tributaries. | Total. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| 1857 | 51,498 | 285,453 | 41,854 | 378,805 |
| 1858 | 31,642 | 177,412 | 35,659 | 244,713 |
| 1859 | 6,180 | 133,294 | 17,128 | 156,602 |
| 1860 | 11,992 | 169,836 | 32,970 | 214,798 |
| 1861 | 23,467 | 179,767 | 29,960 | 233,194 |
| 1862 | 53,804 | 112,487 | 8,785 | 175,076 |
| 1863 | 67,972 | 215,667 | 27,407 | 311,046 |
| 1864 | 49,151 | 310,421 | 56,169 | 415,741 |
| 1865 | 36,641 | 291,306 | 66,576 | 394,523 |
| 1866 | 33,204 | 232,388 | 70,555 | 336,147 |
| 1867 | 39,679 | 230,810 | 35,106 | 305,595 |
| 1868 | 56,798 | 175,812 | 52,695 | 285,305 |
| 1869 | 49,460 | 191,194 | 34,576 | 275,230 |
| 1870 | 37,258 | 182,836 | 56,859 | 276,953 |
| 1871 | 43,897 | 156,249 | 73,081 | 273,227 |
| 1872 | 44,611 | 128,097 | 36,344 | 209,052 |
| 1873 | 92,448 | 218,139 | 48,659 | 359,246 |
| 1874 | 91,986 | 277,093 | 63,646 | 432,725 |
| 1875 | 29,871 | 244,474 | 23,294 | 297,639 |
| 1876 | 16,124 | 163,826 | 23,636 | 203,586 |
| 1877 | 8,903 | 132,996 | 34,693 | 176,592 |
| 1878 | 11,438 | 155,138 | 68,928 | 235,504 |
| 1879 | 15,135 | 115,683 | 62,213 | 193,031 |
| 1880 | 22,899 | 101,720 | 32,791 | 157,410 |
| 1881 | 73,504 | 125,766 | 81,189 | 280,459 |
| 1882 | 58,369 | 188,084 | 35,817 | 282,270 |
| 1883 | 28,638 | 210,349 | 26,443 | 265,430 |
| 1884 | 30.431 | 178,419 | 16,664 | 225.514 |
| 1885 | 26 826 | 121,010 | 11,220 | 159,056 |
| 1886 | 20,400 | 64,458 | 10,595 | 95,453 |
| 1887 | 56,488 | 83,061 | 10,901 | 150,450 |
| 1888 | 101,103 | 105,125 | 11,859 | 218,087 |
| 1889 | 107,080 | 111,852 | 12,202 | 231,134 |
| 1890 | 108,525 | 169,089 | 16,505 | 294,119 |

The comparison between lake and coast building in the foregoing table is particularly flattering to the inland seas. During the past few years the work of the lake ship-yards has been fully equal to that of the Atlantic Coast and almost equal to the entire coast work, while in the previous period of 20 years there was no comparison between them, on account of the big output on the Atlantic.

## Recent Patents.

### CONNELL'S RAIL-JOINT.

THE accompanying illustrations show a rail-joint invented by William H. Connell, of Wilmington, Del., and covered by Patent No. 439,116. The nature of the invention can be easily understood from the drawings, in which figs. 1 and 3 are side elevations and figs. 2 and 4 end elevations of the joint. It will be seen that it is a truss joint, the fish-plates having a lug on each end which may be formed in several different ways, which

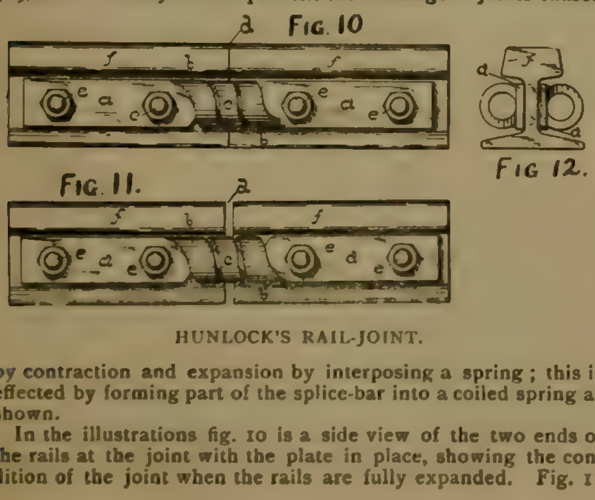



CONNELL'S RAIL-JOINT.

will readily suggest themselves. Through these lugs pass the tie-rods or truss-rods *E E*, which are held by the nuts *e e*, thus giving additional strength and support to the joint. The angle bars are bolted in the ordinary way through the rail by the bolts *D D D*. The truss-rods pass under the strut *F*, which, as shown in the drawing, is a short piece of rail. Old rails can very well be utilized for this purpose, but, of course, the strut can be made of any other suitable form. In adjusting the joint the splice-bars *C* are first secured to the rails by the bolts, the tie-rods *E E* being inserted in the lugs of the splice beforehand. The strut *F* is then stepped beneath the joint in the proper position and the nuts *e e* are screwed up, forcing the strut up against the bottom of the joint between the rails and making a joint which, the inventor claims, will be very strong, stiff, and compact.

### HUNLOCK'S RAIL-JOINT.

Figs. 10, 11, and 12 show a form of rail-joint patented by John G. Hunlock, of Wyoming, Pa., the patent being No. 429,628. The object is to prevent the breakage of joints caused




HUNLOCK'S RAIL-JOINT.

by contraction and expansion by interposing a spring; this is effected by forming part of the splice-bar into a coiled spring as shown.

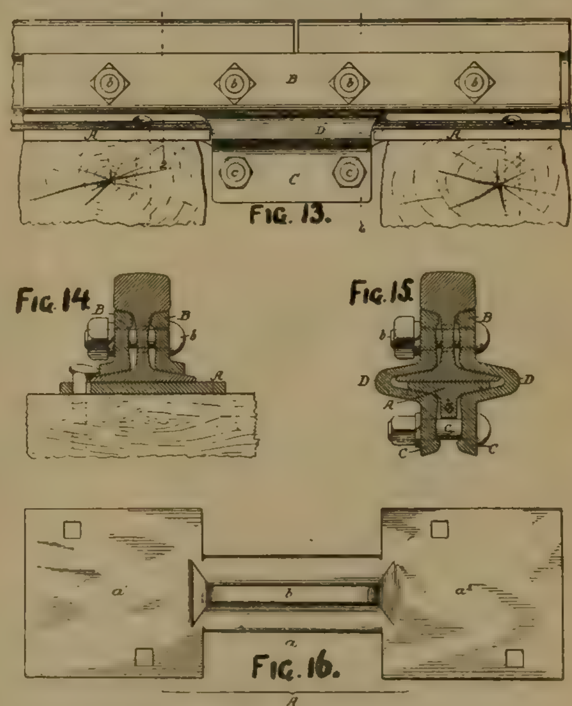
In the illustrations fig. 10 is a side view of the two ends of the rails at the joint with the plate in place, showing the condition of the joint when the rails are fully expanded. Fig. 11 is a side view of a similar joint, showing its condition when the rails have become somewhat contracted by a change of temperature or from other causes. Fig. 12 is an end view of the rail with plates in place, bolt-heads having been omitted. In these *a* and *a* are the flat ends of the plate through which the bolts go, by which the plates are bolted to the rails; *f* and *f* are the ends of the rails, to which are bolted the plates; *b b* and *c* compose an intermediate part of the plate between the two ends or arms *a*, and are formed into a helix branching from *a* at *b* with an enlarged section. It is gradually reduced in section until at the point *c* it has attained its smallest section. The object of this gradual reduction in section is to obtain a maximum elasticity in the central coil, where only a torsional or twisting strain is produced. In order to reduce the transverse or bending strain at the junction of *b* with *a*, *e e e e* are the bolts by which the plates are held in place; *d* indicates the opening between the ends of the rails.

### CHURCHILL'S RAIL-JOINT.

A form of rail-joint covered by patent No. 433,273, issued to Charles S. Churchill, of Roanoke, Va., is shown in figs. 13–16. Fig. 13 is an elevation; fig. 14 a section through the tie; fig. 15 a section through the bridge-plate; fig. 16 an inverted plan of the bridge-plate.

The bridge-piece *A* consists of a plate of iron or steel formed of a narrow central section *a*, provided with a strengthening-rib *b* on its under side, and two broad end sections *a' a²*, extending over and adapted to be secured to the ties. By this construction the weight of the rail and train is distributed over a large surface of the ties, while the ribbed-bridge portion is sufficiently strong, in connection with the angle-bars, to withstand the weight of the rails and train and transmit it to the ties.

The angle-bars or fish-plates are of the peculiar construction best shown in fig. 15, each consisting of an upper part *B* and a lower part *C*, connected together by an outwardly curved and inclined portion *D*, embracing both the bridge-piece and the lower flange of the rail. The parts *B* extend for a considerable distance along the sides of the rails, in the manner common to ordinary fish-plates, and are secured to the rails and to each other by bolts *b'*. The parts *C* are made short enough to fit in between the adjoining ties, and the bolts *c*, which serve to bind them together, pass beneath the ribbed bridge-piece, as shown




CHURCHILL'S RAIL-JOINT.

in fig. 15, or through the same. It will also be noticed that the inclined portions *D* of the angle-bars fit snugly against the inclined flanges of the rail and the inclined under side of the bridge-piece *A*, so that when the bolts *b* and *c* are tightened the parts are pressed into close contact and the whole structure is bound firmly together, preventing the deflection of the rail ends or the creeping of the rails.

# Manufactures.

## General Notes.

THE Berlin Iron Bridge Company has increased its capital stock from $125,000 to $300,000, the new stock being all taken by the old stockholders. The additional capital will all be invested in improving and enlarging the plant at East Berlin, Conn., where work will be begun at once on a new building 80 × 600 ft. in size.

THE shops of H. K. Porter & Company, in Pittsburgh, have completed two Forney locomotives of 4 ft. gauge for the United States Government. These locomotives are for the Muscle Shoals Canal improvement in Alabama, and are to be used for towing barges through the canal. Each locomotive is fitted with four heavy hooks to which the tow lines are connected.

THE Wason Manufacturing Company, Brightwood, Mass., is building 20 passenger cars for the Old Colony, 20 for the New York, New Haven & Hartford, and 50 for the Manhattan Elevated Railroad.

THE Scarritt Furniture Company, St. Louis, has recently received orders for Scarritt-Forney seats for 10 cars for the Chicago & West Michigan; also for 79 new coaches now building for the Chicago & Northwestern Railway.

THE New Orleans & Northeastern Railroad, which has some 20 miles of trestle running through the swamps back of New Orleans and over Lake Pontchartrain, has set about the task of filling in the trestle with dirt. This is being done by a new patent dredge boat built by the Bucyrus Steam Shovel & Dredge Company, which is showing itself a wonder in the matter of thowing up dirt, excavating a canal on the side of track, and piling up the dirt under the trestle with great rapidity. The embankment, while proving of great benefit to the railroad, would also advantage New Orleans, since it will serve as a levee to prevent any overflow from Lake Pontchartrain when that lake is swollen by northwest winds.

THE ties made by the Standard Metal Tie & Construction Company, of New York, which were laid in the track of the Chicago & Western Indiana Railroad some 15 months ago, have given excellent results. The roadmaster reports that the work of maintaining the track with these ties has been much less than with wooden ties; they are more easily tamped; the heads of the rails are kept even, and the joints held up; there is no deflection of the rails, and less wear on the rail ends.

THE Navy Department has contracted with Carnegie, Phipps & Company, of Pittsburgh, to furnish 6,500 tons of armor plates for the new ships now building. The first delivery is to be made in June, and the plates are to be delivered at the rate of 500 tons per month.

THE Leslie Brothers Manufacturing Company, Paterson, N. J., is negotiating with the Russian Government for the introduction of the Leslie rotary snow-plow on the railroads of that country. The importance of an improved plow in a country where the snow-fall is heavy is fully appreciated by the managers of the State Railroads.

THE works of the Flood-Conklin Company in Newark, N. J., have recently been almost doubled in capacity to meet the demands of business, which have increased very fast, although the firm only began business last year.

THE Weber Railroad Joint Company has been officially requested to submit its device to the German Government for examination as to its use on the State railroad lines.

THE shops of Pedrick & Ayer, Philadelphia, have recently shipped to the Central Forge Works, at Whitestone, N. Y., a planer for heavy work, planing 8 ft. long and 25 in. wide. This machine, having been specially designed for the work, will cut $\frac{5}{8}$ in. deep and $\frac{1}{16}$ feed. These works have recently finished a new open-side shaper, which is mounted on a column, and will cut 14 × 14 in. square and 31 in. in length, and which is an exceedingly convenient tool for general use.

THE boilers of the steamer *Phra Nang*, which were fitted with the Servé ribbed tubes by the Fairfield Ship-building Company, have now been used in a passage out to China, and the engineer reports that they behaved very satisfactorily, and caused an appreciable saving in coal consumption. An exact estimate will not be made until the vessel has been at work for three months in her regular trade in the China Seas. The boilers fitted with the Servé tubes in the works of John Brown & Company, in Sheffield, have been submitted to continued tests, the latest showing, under high induced draft, a relative economy of 15 per cent. for the ribbed tubes. These tubes have already been described in the JOURNAL, and are to be introduced in this country, Mr. Charles W. Whitney, of New York, having taken the agency for the same in the United States.

THE automatic temperature regulator of the Consolidated Car Heating Company is now in use by the Wagner Palace Car Company, and on the Boston & Maine, the Fitchburg, the Buffalo, Rochester & Pittsburgh, the Baltimore & Ohio, and the Delaware & Hudson Canal Company's road. The company's fire-proof heater is now in use on the New York, Providence & Boston, the Boston & Maine, the Intercolonial, and the Lehigh Valley roads, and by the Wagner Company.

THE business of the Dunham Manufacturing Company has been transferred to a new organization, known as the Q. & C. Company, the officers of which are: W. L. Findley, President; C. F. Quincy, Treasurer, and Arthur Crandall, Secretary. The new company will continue the manufacture of the various articles which the Dunham Company has introduced in railroad work, including car doors, brake adjusters, ventilators, the Servis tie-plate and the Davies spike.

THE portable rope hoisting machines made by the Energy Manufacturing Company, Philadelphia, have been adopted by the Pennsylvania, the Philadelphia & Reading, the Lehigh Valley, and other roads, and by a large number of manufacturing establishments.

A NEW system of ventilation for fruit and other cars has been devised by Mr. R. M. Pancoast, of Camden, N. J. It can be readily applied to existing cars, and the inventor claims that it will not only admit air and exclude dust, but that it will maintain a sudden circulation of air passing directly over the load and will carry off all impure air, keeping the interior of the car cool and fresh, a condition which is essential to the proper transportation of fruit and similar freight.

THE Consolidated Car Heating Company has recently equipped a number of private cars, including one built for Austin Corbin; one for the President of the Canadian Pacific; one for the New York, Lake Erie & Western; one for the Lehigh Valley; several pay cars of the New York Central & Hudson River Railroad have been equipped with the consolidated commingler system. The Delaware & Hudson Canal Company has recently changed its Albany Belt Line trains from direct steam to the commingler storage system, with temperature regulator. The piping formerly in the cars was used, and they are now heated at will by direct steam, or by circulating hot water. The Canadian Pacific and the "Soo" lines have recently given considerable contracts for car heating to this company, which has also new orders on hand from the Boston & Maine, the Old Colony, the Fitchburg, and the Grand Trunk. On March 11 and 12 the Company will have an exhibition of its system as applied on the Albany Belt trains.

THE Brooks Locomotive Works, Dunkirk, N. Y., have recently built a number of 10-wheel engines for the Wisconsin Central Railroad. These have 18 × 24-in. cylinders and 63-in. driving-wheels. The boilers are 54 in. diameter of barrel, with a grate area of $18\frac{1}{2}$ sq. ft., and 1,600 sq. ft. heating surface. They will carry a pressure of 180 lbs. The total weight of these engines is 118,000 lbs., of which 88,800 lbs. are on the driving-wheels. The tenders weigh 75,000 lbs. loaded, and will carry 3,700 galls. of water and eight tons of coal.

## A New Double-Screw Ferry-boat.

A NEW ferry-boat for the New York, Lake Erie & Western Railroad Company has recently been completed at the yards of Neafie & Levy, in Philadelphia, and will be used in the Company's ferries across the Hudson River, at New York. This boat resembles the *Bergen*, of the Hoboken line, in having a screw propeller at each end, the shaft running the entire length of the boat, and is the second of this class on the river, the *Bergen* being the first. All the other ferry-boats on the Hudson are side-wheel boats. The new ferry-boat is 215 ft. long over all; 188 ft. 3 in. long between stern posts; 45 ft. beam moulded; 62 ft. over guards, and 16 ft. depth of hold. The engines are compound surface-condensing engines, with cylinders 26 and 50 in. diameter by 30 in. stroke. The propellers are 8 ft. 6 in. in diameter. The high-pressure cylinder has a piston valve and the low-pressure a plain slide valve, both driven by a link mo-

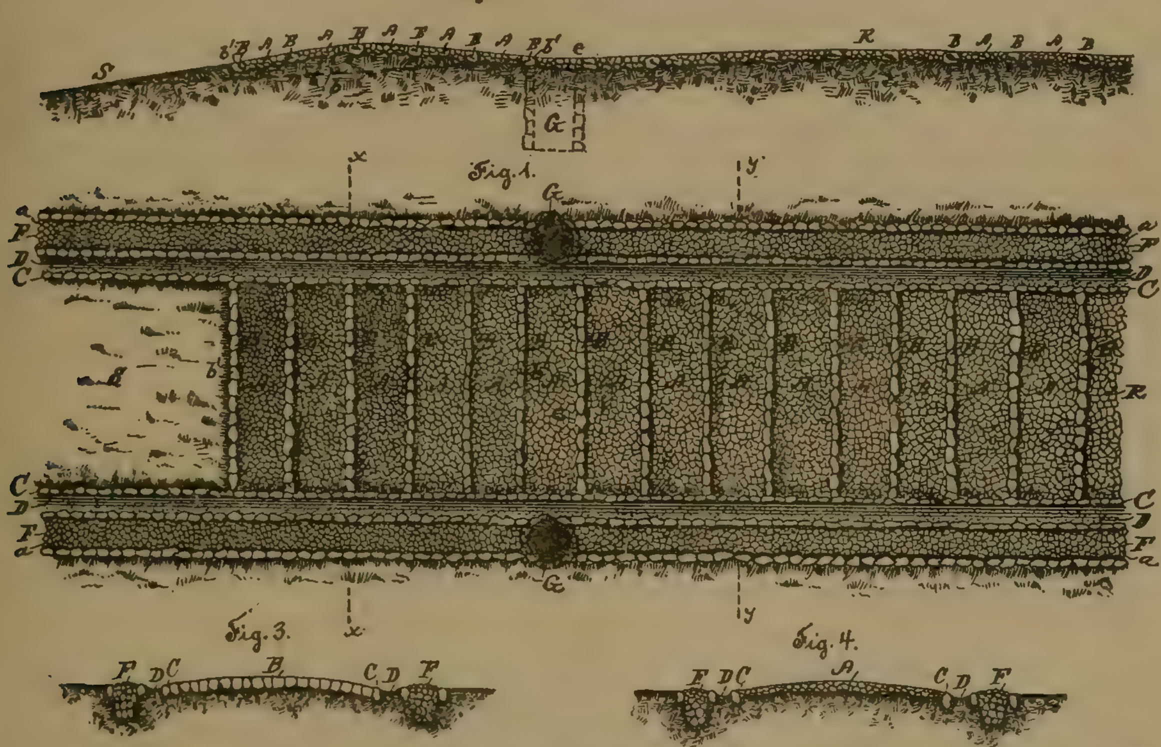
tion. The reversing is done by a small steam-engine. There are two boilers, 12 ft. 8 in. in diameter and 11 ft. long. The working pressure will be 100 lbs. The cabins are handsomely fitted up, and the boat is provided with an electric light plant.

## A New Plan of Highway Construction.

THE accompanying illustrations represent an improved method of road construction devised and patented by C. E. Keach, of Mapleville, R. I., fig. 1 being a plan of a short section of road-bed ; fig. 2 a longitudinal section ; fig. 3 a cross-section on the line *x x*, fig. 1 ; fig. 4 a cross-section on the line *y y*, fig. 1.

It will be seen that the road is divided lengthwise into a series of sections *A A A*, which are separated from each other by transverse rows *B* of comparatively large stones, while the spaces *A* between said rows are filled with smaller broken stone or stones and gravel. The rows of stone *B* are placed equidistant along the road-bed and serve as supporting-walls, which inclose the gravel between them and prevent the same from shifting, whereby the road might otherwise become uneven. Rows of stones *C* of about the same size as those of the rows *B* are placed on both sides of the road-bed and serve as walls in conjunction with the said rows *B*. Adjoining the rows of stone *C* and running lengthwise of the road are shallow drains *D*, which serve to catch the sand or other fine material which may be washed from the higher portion of the road-bed while the water which accompanies it will flow into the parallel deeper drain *F*, which latter is filled with cobble-stones *a*. The dry sand which is washed from the road-bed and settles in the drain *D* can be readily returned to the road-bed or be removed to a suitable place of deposit.

Fig. 2.




KEACH'S IMPROVEMENT IN HIGHWAY CONSTRUCTION.

In order to prevent a rush of water from the comparatively level portion *R* of the road at the top of a hill *S* down the road-bed, so as to wash and gully the same, near the top of the incline *S* a shallow depression *c* is made in the road-bed ; the water is drained from the same by the side drains *D*, which in this case are inclined, as is indicated by the dotted line *b* in fig. 2, so that the portion of the road-bed included between the lateral rows of stone *b' b'* will form a raised dam or bar, which will serve to prevent the water from rushing down over the inclined road-bed of the hill *S* to wash and gully the same ; and in this case also the dam will be constructed of a series of transverse rows of stone *B* with the spaces *A* between the rows filled with fine stone and gravel, and such dams or bars can be made at different parts of the declivity of the hill as may be required to properly guide the water from the road bed.

In the absence of stone of the required size to form the walls *B* and *C* the same can be made of gravel and cement or other suitable material, and in some cases logs of wood can be employed.

Dry-wells *G* may be provided at suitable intervals in the blind drains *F*, whereby the water from the drains will be absorbed by the surrounding earth or gravel.

## Jet Water Wheels.

(From *Industry*, San Francisco.)

THE Pelton Water Wheel Company, of San Francisco, will in their tender for the motive-power plant at Niagara Falls labor under several disadvantages that should have consideration by the Commission, who are to decide between the various wheels and firms competing.

In the first place, there is no popular understanding of what may be called tangential or jet wheels among people at the East or in Europe, and very little among engineers, except as the Girard type of wheels may be thus classed ; but the difference between the California and the French wheel is very wide, both in construction and in a hydraulic sense.

The Pelton wheels employ round jets impinging on peculiarly formed vanes, both of which features admit of definite mathematical treatment and constitute very marked advantages over the oblong jets and Jonval floats or vanes of the Girard type of wheels.

This branch of the subject has received considerable attention from the engineering faculty of the University of California, and especially from Mr. Ross E. Browne, Hydraulic Engineer, of San Francisco, who assisted at the University experiments conducted in 1883. A bulletin was issued containing the data and results, which constitutes the first literature of the California wheels that found its way into the outer world. Since that time no laboratory tests of these wheels have been made, but there has been a vast amount of observed data which has not only confirmed Mr. Browne's results and computation, but also exceeded in practical use what was laid down or inferred from the laboratory experiments above named.

The wheels are, therefore, in a sense not well known, mainly for the reason that the circumstances which led to their development here in California do not exist elsewhere—working heads of from 100 to 1,000 ft., and even 1,500 ft. Except in the mountainous districts of Europe, where power is but sparingly re-

quired, there is no parallel to these requirements of the Pacific Coast, where every stream is torrential until it reaches the plains.

In the Eastern States, or, as we may say, in the water wheel practice of the world, a fall exceeding 50 ft. is seldom to be dealt with, and among the numerous makers of turbine wheels there has not been much adaptation for higher heads or pressure. This is especially true of the American inward-discharge class of wheels, which have a higher rotative speed than either the Jonval or Fourneyron types, and are consequently less suited for high heads, and where there have been attempts to use them, as in the present plants at Niagara Falls, only a part of the head is utilized, the rest going to waste.

The economical gain by the inward-discharge method of constructing turbine wheels is that the wheel itself, or the running part, which requires finishing, is small in diameter and consequently less expensive to construct. The results attained are much better than theoretical computations or inferences assign to the method, and aside from high rotative speed and consequent inadaptation to high heads, inward-discharge wheels mark a notable advance in hydraulic practice.

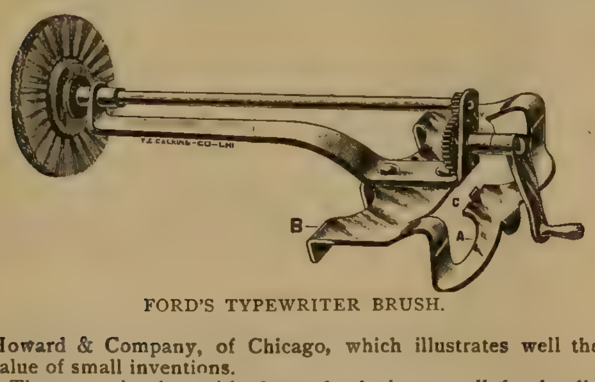
At Niagara Falls the makers of turbine wheels meet almost their first experience of California heads, and 140 ft. of fall, with a pressure of 60 lbs. to the square inch, impresses them the same as a fall of 700 ft. and a pressure of 300 lbs. to the square inch does a California engineer, or maker of water wheels. It is a case of transposition, and outside of facts and computations, the Pelton Water Wheel Company may expect at first but little support for their methods.

This is the disadvantage we alluded to at first, and what its weight may be with a scientific commission who are supposed to deal with the problem *a priori* remains to be seen. There are, however, indications of a better understanding of these California water wheels than was at first hoped for. Mr. Ferranti, the Engineer of the power company organized to erect works on the Canadian side at Niagara Falls, and who is one of the most eminent engineers of our time, has detected the peculiar claims and advantages of the tangential water wheels for driving his dynamos, and we are well satisfied that his preference for these wheels will be strengthened by further investigations on his part. . . . . .

It is a strange circumstance, but one not without precedent, that we should, after some centuries of experiment, find in the simple tangential jet water wheel not only the most simple one in form, but that which most nearly conforms to hydraulic laws. During all this time we have been either dividing high falls into sections or utilizing only so much of them as would suit the kind of wheels in common use.

## A Convenient Invention.

THOSE who use typewriters—and that includes almost every one nowadays—have felt the want of some method of cleaning the type. This is met by a very neat device made by Ford,




FORD'S TYPEWRITER BRUSH.

Howard & Company, of Chicago, which illustrates well the value of small inventions.

The engraving herewith shows the device so well that hardly any description is needed. It consists only of a revolving brush, carried on a light frame.

The brush is rapidly rotated by means of gears (a special feature of this brush), the proportion of revolutions being three of the brush to one of the hand. This speed not only cleans and dries the type, but really polishes it. The bristles are three rows deep, ¾ in. in length, and of the best quality. The brush operates parallel with the type bars, thus preventing all liability of straining them.

All that need be added is that by simple changes in the frame it can be fitted to any machine, and that on our own Remington it works like a charm.

## Some New Wood-Working Machines.

THE object of car builders and railroad shops is usually to secure machinery which will produce the largest quantity of good work in a given time, and to meet this demand the machines shown in the accompanying engravings have been designed.

Fig. 1 shows the special rapid-feed flooring machine, which will work 100 lineal feet of practically perfect flooring per min-

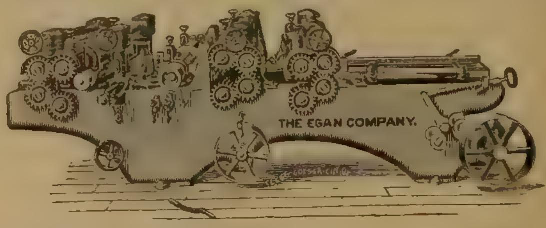



FIG. 1.—SPECIAL RAPID-FEED FLOORING MACHINE.

ute, without trouble, annoyance or breaking down, either in white pine, yellow pine, or hard wood of any kind. It is powerfully built to stand any strain, and all adjustments are simple, strong and reliable. The gearing is new, without links of any kind. The feed consists of six 9-in. rolls, geared up in the best manner, and held down by strong steel springs capable of standing a pressure of seven tons; this pressure can be increased or decreased as desired by a small hand wheel. These feed rolls are provided with improved scrapers, which enable them to run in the gummiest yellow pine without taking any dirt. The pressure-bars are of the best improved character, hugging the knives closely, and are adjustable, giving the machine all the advantages of an inside moulder, and enabling the operator to adjust them to do the smoothest and most per-

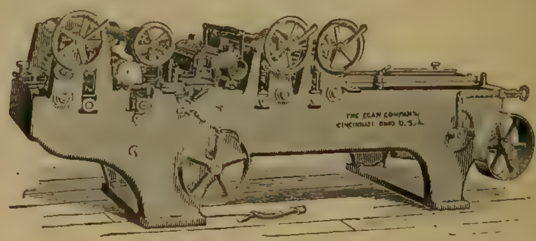


FIG. 2.—FAST-FEED FLOORING MACHINE.

fect work, preventing all tearing out, even in cross-grained wood, thus giving a cut that all mill men look for, free from vibration and tremble.

The side heads are shimers made especially for this machine, and the spindles run in long connected bearings, and are adjustable to any point across the width of the bed, fitted with an improved matcher clip and a great help even to the shimer-head. An independent beader and a pressure-bar for the lower cylinder are placed on this machine, and can be instantly swung out of the way when not wanted or when the operator wishes to sharpen or get at the knives on the lower heads. The beader can be drawn clear back from the cut when not wanted.

Two sizes are made, to work 9 in. and 14 in. wide, and to work three or four sides.

Fig. 2 represents another form, the fast-feed flooring machine, for fast work and quick adjustments, having a capacity of 80 to 100 ft. per minute, capable of standing up to any kind of work, such as flooring, patent siding, beading, ceiling, mouldings, and work of that class, doing it perfectly and reliably. The frame is built upon an improved plan, and will stand any strain that will be put to it.

The cutting cylinders are of the best steel and slotted on all four sides, each side having a knife. The feed consists of six 7-in. rolls, all heavily geared. The system of gearing on this machine is entirely new, all the rolls being driven by internal and external gearing, without expansion links; each upper feed-roll is made to lift parallel, thus giving a full and even pressure across the surface of the board; this is effected by a new and ingenious device for raising and lowering the upper rolls, which can be done instantly to accommodate the thickness of stock. The upper front feed-rolls are held down by a new weighted equalizing bar, allowing ample lifting range to suit unequal stock. The other features are the same as in the rapid-feed machine described above. Two sizes are made, to work 9 in. and 14 in. wide, and to work three or four sides. The former machine is especially recommended for the extra heavy work in large mills and the latter for planing mills, etc., where a first-

class machine is wanted for general work. Both have been very successful in practice.

Both machines have been designed and built by the Egan Company, and further information can be obtained from that Company, whose address is Nos. 194–214 West Front Street, Cincinnati, O.

## Notes from Baltimore.

THE engine for the new manufacturing enterprise at Curtis Bay, established by the Ryan & McDonald Manufacturing Company, was started up February 10 to test the machinery, and work was begun on the 15th with about 50 mechanics, on contracts taken for locomotives, hoisting engines and small cars.

Arrangements are being made for the construction of an Electric Railroad from a point in South Baltimore to Curtis Bay.

The South Baltimore Car Works, Curtis Bay, have secured an order from the Baltimore & Ohio Railroad for making general repairs to freight cars.

The Baltimore Car Wheel Company are arranging their plant for the manufacture of electrical appliances.

The passenger conductors of the Baltimore & Ohio have had their pay increased, to take effect February 1.

Mr. J. F. Legge, formerly Superintendent of the Western Division, Baltimore & Ohio Railroad, has been appointed General Agent and Superintendent of Wheeling Terminals, with headquarters at Wheeling, W. Va.

## OBITUARY.

JOHN DIXON, who died in England, January 28, aged 56 years, was well known as an engineer. He served as apprentice under Robert Stephenson, and was for many years employed in works constructed abroad by English contractors. He built the first experimental railroad in China, from Shanghai to Woosung, which was afterward taken up. He built railroads also in Portugal, Spain and other countries, and harbor works in South Africa.

HIRAM FOWLER, who died in Westfield, Mass., February 3, aged 60 years, was for many years a civil engineer well known through Connecticut and Massachusetts. He was engaged in a number of works both railroad and city. He was Chief Engineer of the Connecticut Valley Railroad, having charge of its construction from Saybrook to Hartford, and after its completion was made Superintendent, holding that position until it was purchased by the New York, New Haven & Hartford Company.

JOSHUA L. PUSEY, who died in Wilmington, Del., February 8, aged 71 years, was born in Chester County, Pa., but removed to Wilmington at an early age. He learned his trade with the old firm of Betts & Harlan, in Wilmington, and in 1848 founded the firm of Pusey & Jones, in the first place owning only a small machine shop, which gradually grew into the present large shops and shipyard of the Pusey & Jones Company. The present corporation was organized in 1879, Mr. Pusey holding a large interest, and he has been President for four years past, having returned to active business in 1886 after a short period of retirement.

JACOB N. MCCULLOUGH, who died in Allegheny, Pa., February 8, aged 68 years, was originally a business man in Pittsburgh, but many years ago was induced to take charge of the Cleveland & Pittsburgh Railroad, then almost bankrupt, to save some interest which he owned in the road. He managed the road for several years, bringing the Company up into good condition, and in 1863 was made General Superintendent of the Pittsburgh, Fort Wayne & Chicago Railroad, which was very largely improved under his charge. When the road was leased to the Pennsylvania Company, in 1871, he was made General Manager, and when the Pennsylvania Company was organized, he was chosen First Vice-President, which position he retained until his death, being the chief executive officer of the Pennsylvania System west of Pittsburgh. Mr. McCullough was not an engineer, but was distinguished among railroad men for his ability as a financial manager and in building up and securing traffic.

ROBERT FORESTER MUSHET, the maker of the celebrated "special tool steel," died February 3, in his 80th year.

In recording his death, the London *Engineer* says: "Mr. Mushet was the youngest son of the late David Mushet, whose labors in the field of iron metallurgy were among the most fruitful in results to British industry in the earlier years of the present century; the most important of them, the discovery of the black band ironstone, having created the Scottish iron trade; while his researches into the manufacture and properties of steel were among the first to throw light upon a then very obscure subject. In the latter field the son became a worthy follower in his father's footsteps, and devoted the greater part of his life to the improvement of the manufacture of crucible steel at his small experimental works at Coleford, in the Forest of Dean, where several notable developments originated, among them being the introduction of China clay into the mixtures for crucibles, whereby they were made more refractory and capable of longer service than before, and the production of specially hard steel by the addition of tungsten and other metallic elements to the iron in the crucible, which resulted in the production of the well-known "special tool steel," which has proved of immense value in the engineer's workshop. These results were, however, overshadowed by his application of spiegeleisen to the Bessemer process, which in the words of the late Mr. Menelaus, in 1876, the President of the Iron & Steel Institute, 'was one of the most elegant as it was one of the most beautiful of processes in metallurgy.' From the narrative published by the inventor himself in 1883, recording the steps that led to this application of manganese to iron when melted in large masses, it will be seen that it was no mere lucky hit, but the result of long continued and careful experiment, and it is sad to think that the discoverer lost the fruits of his labor through the trustees of his patent omitting to pay the fees due in the third year. The value of the discovery was, however, fittingly acknowledged by the award of the Bessemer Gold Medal of the Iron & Steel Institute in 1876, and in a more substantial manner by Sir Henry Bessemer."

DR. N. AUGUST OTTO died in Cologne, Germany, January 26, after a brief illness. He started in life, says *Engineering*, as a commercial traveler, for which duties his great mechanical skill was of little avail. Some circumstance turned his attention to gas engines, where his commercial capacity remained valuable. In 1867 he, in conjunction with Eugen Langen, surprised the engineers who had flocked to the Paris Exhibition with a real practical gas engine, an engine of the vertical type, with fly-wheels on the top, not uncanny in appearance, but terribly noisy. The noise had to be borne, and was borne—for the new engine became very popular—for nine years, when the "Otto Silent" was presented. That engine has undergone such manifold improvements that startling innovations and perfections are hardly to be looked for.

The gas engine, in its practical career, has thus quickly attained maturity. Yet the early history of the gas engine has to go back more than 200 years. It is orthodox to quote Huyghens as the first in the field; the series of originators commences, therefore, with one of the best names of physical science. Among the papers of the great physicist is one dated 1640, on a "Novel Motive Force Derived from Gunpowder and Air. Papin took this idea up in 1688, one year after his classical experiment which initiated the steam-engine; but he was not satisfied with the results. Fully a century later, Stree reopened the researches by bringing out and patenting a motor cylinder with explosion by means of a torch. Many others followed, Lebon, Samuel Brown, Wright, Barnett, Newton, Barsanti and Matteucci, Million, and Lenoir, and Hugon, who came very near producing a practical engine. But Langen and Otto's engine of 1867 was so decidedly superior in the economy of gas consumption that the Lenoir and Hugon engines were at once put out of the field. Otto's gas engine embraced the characteristic features of some of its predecessors—it is rarely otherwise in our days—the compression of Barnett, the cycle of Beau de Rochas, and the free piston and other advantages of Barsanti and Matteucci's engine, which was remarkable in many respects, and effected ignition by means of the electric spark. But engineers remain indebted to Dr. Otto for supplying an engine which realized and did what others, who deserve all credit, had been aiming at. We will not here contest the question of priority of invention. It has been fought out many a time; and we believe that no one will grudge Dr. Otto the benefits and comfort which his work and exertions brought him.

He was an honorable man, esteemed by all who knew him, and his invention was not a lucky hit. He was not trained as an engineer, but he made himself one by hard work and study; and his achievements prove his great theoretical knowledge, mechanical dexterity, and fertility of resources.

## PERSONALS.

H. R. THOMAS has been appointed Railroad Commissioner of South Carolina, succeeding the late M. L. BONHAM.

J. S. CAMERON has resigned his position as Chief of Construction of the Union Pacific Railway.

FRANK W. KANE is now Engineer in Charge of Construction of the Pecos Valley Railroad, in Texas.

G. A. O'KEEFE is now Master Mechanic of the Detroit, Lansing & Northern Railroad, with office at Ionia, Mich.

HUNTER McDONALD is now Chief Engineer of the Western & Atlantic Railroad, succeeding the late EBEN PARDON.

GEORGE D. BROOKE is now Master Mechanic of the St. Paul & Duluth Railroad, succeeding CHARLES F. WARD, resigned.

CHARLES GRAHAM, Jr., is now Master Mechanic of the Bloomsburg Division of the Delaware, Lackawanna & Western Railroad.

ELWOOD S. SCHUTZ has been appointed Master Car-Builder of the Georgia Railroad, succeeding T. M. PREVAL, who has been assigned to other duty.

ARTHUR P. HERBERT is now engineer and Superintendent of the Colima Division of the Mexican Central Railroad ; his headquarters are at Colima, Mexico.

DAVID BROWN is now Master Mechanic of the Delaware, Lackawanna & Western Railroad, having charge of the motive power and machinery of the main line.

S. H. HARRINGTON has resigned his position as Mechanical Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railroad, and will devote his time to introducing his signal system and some other inventions.

FREDERICK P. DEWEY, late of the National Museum, has established in Washington a laboratory for the analysis of ores and other substances, the investigation of chemical and metallurgical processes and other similar work.

VIRGIL G. BOGUE, for many years Chief Engineer of the Union Pacific, has resigned, but will continue to have charge of the construction of the company's new line in Oregon. Mr. Bogue's successor is E. C. SMEED, late Assistant Engineer.

F. W. D. HOLBROOK, C.E., recently Manager of the Seattle, Lake Shore & Eastern Railroad, has accepted the position of Secretary of the new Board of Public Works, at Seattle, Wash. Mr. Holbrook is an engineer of experience and standing.

CHARLES GRAHAM has resigned his position as General Master Mechanic of the Delaware, Lackawanna & Western Railroad. He has been connected with the road for many years in various capacities, and now retires on account of ill health.

JOHN D. CAMPBELL is now Assistant Superintendent of Motive Power of the New York Central & Hudson River Railroad. He was formerly on the Central Railroad of New Jersey, and more recently on the Manhattan Elevated Railroad in New York.

PHILIP WALLIS is now Master Mechanic of the Eastern Division of the Norfolk & Western Railroad, with office at Roanoke, Va. He was recently Division Master Mechanic in charge of the shops at Creston, Ia., on the Chicago, Burlington & Quincy Railroad.

HARVEY MIDDLETON has resigned his position as Superintendent of Motive Power of the Union Pacific, and is succeeded by JOSEPH McCONNELL. Mr. Middleton has shown much ability and has many friends, and his retirement is due entirely to the change in administration of the company.

CAPTAIN EDMUND BERKELEY has been appointed Superintendent of the Richmond & Danville Railroad. C. P. HAMMOND succeeds Captain Berkeley as Superintendent of the Atlanta & Charlotte Division. W. B. RYDER, formerly on the Chesapeake & Ohio, succeeds Mr. Hammond as Superintendent of the Georgia Pacific Railroad.

## PROCEEDINGS OF SOCIETIES.

**American Society of Civil Engineers.**—The principal business transacted at the annual meeting in January was the discussion of the reports of the Committee on Amendment of the Constitution, and a number of amendments were ordered submitted to letter ballot. The different standing committees reported progress.

The report of the Board of Directors showed a total of 7 honorary members ; 3 corresponding members ; 1,080 active members ; 61 associate members, and 215 junior members. There are also 56 fellows of the Society. Additions during the past year were 150.

The Norman medal was awarded to John R. Freeman for his paper on Experiments Relating to the Hydraulics of Fire Streams. The Rowland prize was awarded to the paper on the Sibley Bridge, by O. Chanute, J. F. Wallis and W. H. Breithaupt.

AT the regular monthly meeting, February 4, the tellers announced the following elections : *Members :* Patrick J. Flynn, Tulare, Cal.; Conway B. Hunt, Washington, D. C.; Norton Taylor, Tacoma, Wash.

*Junior :* Maurice A. Viele, New York.

A paper on the Use of Asphalt in Building Sea Walls, by W. C. Ambrose, was read. It referred especially to the construction of a wall on the Southern Pacific in Southern California, where the asphalt used was from California bituminous rock. This was discussed by members present.

A paper on the Howe Strut Problem, by N. J. Conover, of too mathematical a nature to be read, was ordered printed.

**Canadian Society of Civil Engineers.**—The annual meeting was held in Montreal, January 16. The Secretary reported total expenditures of $3,591, with a balance of $2,730 on hand. The building fund now amounts to $2.840 ; a number of donations to the library were received. There are now 633 members in all.

The Gzowski medal was awarded to H. P. Vauteler for his paper on Bridge Construction.

The following officers were elected : President, Sir Casimir Gzowski ; Vice-Presidents, J. Kennedy, E. P. Hannaford and F. J. Lynch ; Treasurer, H. Wallis ; Secretary, H. T. Bovey ; Librarian, F. Chadwick.

**Engineering Association of the South.**—The regular meeting was held in Nashville, Tenn., February 12. A paper entitled Weather Forecasts and How to Make Them was read by J. B. Marbury, United States Signal Officer at Nashville. It was followed by a discussion by members present.

**Boston Society of Civil Engineers.**—At the regular meeting, January 21, a Committee was appointed to nominate officers for the ensuing year.

Papers were read on Survey Outfits by Frank P. Johnson, and on the Improvement of the Upper Missouri, by Lawrence Bradford.

**New England Water-Works Association.**—An adjourned meeting was held in Boston, February 11. The paper presented by Mr. Davis at the preceding meeting, describing the moving of 700 ft. of pipe, was discussed, and some further information drawn out.

Mr. George F. Chase read a paper on the Care of Water Mains, with special reference to the effect of the condition of the pipes on the quality of the water. He held that, to keep water supply in satisfactory condition, as much depends on the care of the mains as on that of the reservoir.

Mr. Gowing presented a paper on the Best Means of Laying Water Pipe Across a River. This called out considerable discussion as to whether it was best to lay pipe under a river or on a bridge, and a number of members presented their experience.

Superintendent Forbes read a paper on Driven Wells, having special reference to the best material and form of construction, and to the character of the water obtained by such wells in Brookline, Mass. This paper was discussed by a number of members present.

**Engineers' Club of Philadelphia.**—At the regular meeting, January 17, the Secretary presented, for Mr. George R. Henderson, an illustrated paper upon Locomotive Driving Springs. He had occasion some years ago to examine quite thoroughly the laws governing the deflection of locomotive springs, and found the formula usually given in books to be incorrect, because the shape of the spring is not given due consideration. He constructed a new formula, which he has proved by actual tests in a number of cases.

Mr. Carl Hering read a paper on a Portable Photometer for Measuring Street Lights and Illumination in General. After enumerating the difficulties attending such out-door measurements, he described the portable photometer devised by him, which had given very satisfactory results. The method adopted differed from the usual one in that the standard of light and the unknown light were both on the same side of the screen, and were

balanced by an auxiliary portable light in the photometer at a fixed distance from the screen. The photometer is first calibrated by balancing this auxiliary light against the standard ; this is done indoors. The photometer is then ready for use out of doors, the unknown light being balanced against the auxiliary by moving the whole photometer to or from the light. The adjustments are made so as to reduce the calculations to the simplest possible. The photometer consists of a light wooden tube open at both ends and containing the screen and auxiliary light, together with the switch and tape for measuring the distance. The auxiliary light was a small electric light supplied by a portable accumulator carried by the operator. This photometer could also be used to measure illumination in general, such as daylight, sunlight, moonlight, or the illumination on a table, desk, etc., for which measurements a stationary photometer cannot be used.

THE officers elected for 1891 are : President, Wilfred Lewis ; Vice-President, S. M. Prevost ; Secretary and Treasurer, Howard Murphy ; Directors, Rudolph Hering, Percival Roberts, Jr., F. H. Lewis, R. J. Salom and George S. Webster.

**Ohio Institute of Mining Engineers.**—The eleventh annual meeting was held in Columbus, O., beginning January 22. The annual address was delivered by the President, Mr. Anthony Howells, of Massillon. The meeting continued two days and a number of papers of interest were read, including one by Professor Orton on Corporations and Natural Gas Supplies ; by J. A. Ede on the Minerals of Virginia ; by N. W. Lord on Blast Furnace Tar and Ammonia ; by Andrew Roy on the Lower Coal Measures of the Ohio and Big Sandy, and a number of others.

The meeting was varied by visits to the manufacturing establishments in Columbus and vicinity. Much attention was paid to the works of the Lechner Electric Company, where the specialty is the application of the electric motor to mining machinery.

The following officers were elected : President, Anthony Howells, Massillon ; Secretary and Treasurer, R. M. Hazeltine, Columbus ; Executive Committee, N. W. Lord, F. W. Sperr and Andrew Roy.

**Engineers' Club of Cincinnati.**—At the regular meeting, January 15, Louis Zepernich and John W. Cowper were elected members. On report of the special Committee it was decided that the question of the Club becoming a member of the Association of Engineering Societies be deferred for the present.

Mr. Edwin A. Hill, Real Estate Agent of the Cleveland, Cincinnati, Chicago & St. Louis Railroad, read a paper on Office Records, which comprised a very thorough and comprehensive description of the manner of filing the correspondence, deeds, leases, agreements, etc., and conducting the accounts and correspondence of one of the most important and busy departments of the various railroads comprising the Big Four system.

**Engineers' Club of Minneapolis.**—At the annual meeting, January 15, the following officers were elected : President, Professor W. A. Pike ; Vice-President, T. P. A. Howe ; Secretary and Treasurer, F. W. Capelleu ; Librarian, A. B. Coe.

Arrangements were completed for holding joint meetings with the St. Paul Club in addition to the regular meetings of the Club in Minneapolis.

**Technical Society of the Pacific Coast.**—At the annual meeting in December the following officers were elected : President, John Richards ; Vice-President, Luther Wagoner ; Treasurer, George F. Schild ; Secretary, Otto von Geldern ; Directors, Hermann Kower, Ross E. Browne, C. E. Grunsky, James W. Reid, Alpheus Bull.

AT the regular meeting, January 2, R. B. Elder read a paper on Electrical Accumulators, giving the history and application of storage batteries up to the present time.

Mr. A. T. Herrmann submitted a draft of an act to regulate land surveying. This called out considerable discussion, and it was generally admitted that legislation was very much needed. The subject was finally referred to a special committee with power to revise the proposed bill and submit it to the Legislature.

**Engineers' Society of Western Pennsylvania.**—The annual meeting was held in Pittsburgh, January 20, when the Secretary reported a total of 370 members. The standing committees presented their reports, and the retiring President, Mr. W. L. Scaife, made his annual address.

The following officers were elected for the ensuing year : President, Colonel T. P. Roberts ; Vice-President, A. E. Hunt ; Secretary, J. H. Harlow ; Treasurer, A. E. Frost.

Mr. Charles F. Scott read a paper on Electrical Plant for Mining Coal, the discussion of which was postponed until the next meeting.

**Southern Society of Civil Engineers.**—A meeting was held at Jacksonville, Fla., January 20. The President, Mr. L. J. Barbot, of Charleston, S. C., delivered an address, which was ordered printed for the use of members. It was resolved that the present officers should hold over for another year.

A number of new members were elected. It was decided to hold quarterly meetings during the current year, the next one to be at Savannah, April 20, and the third at Charleston, July 20. The place and date of the October meeting will be announced hereafter.

**New England Railroad Club.**—The regular monthly meeting was held in Boston, February 11. The subject for discussion was the Painting of Cars, which was opened by Mr. Charles Richardson, who spoke at length, saying that interior decoration is an important factor in railroad economy, for no car is complete or acceptable to the traveling public unless good taste has been used in making it attractive. This accomplished, distances seem shorter and trips pleasanter to the passenger and better patronage for the road is secured. The exterior painting, decorating and varnishing of passenger and freight cars are also real problems to be solved. It is difficult to slight this work, except at the expense of durability. The quality of material used is more important than the price. Many of the articles, such as oil and varnish, should be bought in large quantities, allowing them time to become well settled before using. All material should be pure and finely ground. The mixing or preparing of paint should be in the hands of one person, who should weigh and measure each article rather than guess at quantities. Many coatings are not advisable ; light coatings dry quicker, harder, and are less liable to crack, scale or fade. Always use pure linseed-oil.

A number of Master Painters from different roads were present and a long discussion followed these remarks, the speakers being Messrs. Brown and Lange of the Old Colony ; Hibbard and Jewett, of the Boston & Albany ; Nelson and Walton, of the New York, Providence & Boston ; Worrall, of the Boston & Maine and others.

**Western Railway Club.**—At the regular meeting, in Chicago, February 17, the first subject for discussion was Vertical Plane Couplers, which was continued over from the January meeting.

This was followed by a discussion upon the paper on Counterbalancing Locomotives, which was read at the January meeting.

The third subject was Car Lighting, on which a paper was presented by Mr. George M. Gibbs, Mechanical Engineer of the Chicago, Milwaukee & St. Paul Railroad.

**Central Railway Club.**—At the quarterly meeting, in Buffalo, January 28, the subjects discussed were the Amount of Fastening Necessary on Center Plates and the Amount of Breakage of a M. C. B. Coupler which would Cause the Rejection of a Car.

The following officers were elected for the ensuing year : President, Eugene Chamberlain ; Vice-President, F. B. Griffith ; Secretary, John McBeth.

**American Society of Mechanical Engineers.**—The 23d meeting, which will be the spring meeting of 1891, will be held in Providence, R. I., about the second week in June. The exact time and the arrangements for the meeting will be announced later.

Papers to be read at this meeting must be in the Secretary's hands by May 1 at the latest.

## NOTES AND NEWS.

**The Sault Ste. Marie Canal.**—General Poe has been advised that the contract to build the new lock in the Sault Canal has been awarded to Hughes Brothers & Bangs, of Syracuse, N. Y., their bid being $1,268,500. Work will be begun on the contract as soon as it is possible to get machinery and material on the ground. The lock is to be 800 ft. long and 100 ft. wide.

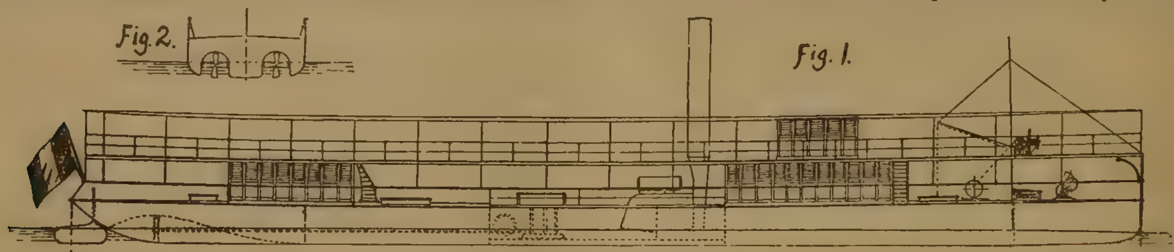
At the mean of low waters there will be a depth of 21 ft. in the lock. At the present stage of water there would be 22 ft. 4 in. In the lock there will be over 80,000 cubic yards of masonry. Over 3,500,000 feet of lumber will be required in its construction. The gates alone will weigh over 1,200 tons. It is hoped that the lock will be completed in five years.—*Marine Review.*

**Photographing Bad Roads.**—The League of American Wheelmen, which is naturally much interested in the improvement of roads, proposes to use for that purpose a series of object lessons, or "awful examples," and has, therefore, offered three prizes for the best collections of photographs showing the actual condition of public roads, by which are meant the ordinary highways and not city streets. The prizes are $50, $30 and $20, and the collection must include not less than three photographs. These should show the actual condition of roads at their worst, with the inevitable results—breakdowns, wagons stuck in the mud, etc. As a contrast, photographs of good smooth roads will also be acceptable. Further information can be obtained from Mr. Charles L. Burdett, of Hartford, Conn., or Mr. Isaac B. Potter, No. 278 Potter Building, New York.

**Detecting Flaws in Iron and Steel.**—Captain de Place, of Paris, has invented an instrument for detecting flaws in metal castings and forgings, which is called the sciséophone. According to the London *Times*, the apparatus consists of a small pneumatic tapper worked by the hand, and with which the piece of steel or iron to be tested is tapped all over. Connected with the tapper is a telephone with a microphone interposed in the circuit. Two operators are required, one to apply the tapper and the other to listen through the telophone to the sounds produced. These operators are in separate apartments, so that the direct sounds of the taps may not disturb the listener, whose province it is to detect flaws. The two, however, are in electrical communication, so that the instant the listener hears a false sound he can signal to his colleague to mark the metal at the point of the last tap. In practice the listener sits with the telephone to his ear, and so long as the taps are normal he does nothing. Directly a false sound — which is very distinct from the normal sound — is heard, he at once signals for the spot to be marked. By this means he is able not only to detect a flaw, but to localize it. Under the auspices of the South-eastern Railway Company, a demonstration of the sciséophone was given recently by Captain de Place in the presence of several members of the Ordnance Committee and other Government officials. Mr. Stirling, the company's Locomotive Superintendent, had previously had several samples of steel, wrought iron and cast iron prepared with hidden flaws known only to himself. The first sample tested by Captain de Place he pronounced to be bad metal throughout, which Mr. Stirling stated he knew it to be. Other samples were tested, and the flaws localized by means of the apparatus. On some of the bars of wrought and cast iron being broken, the internal flaws—the localities of which were known to Mr. Stirling by his private mark —were found to have been correctly localized by Captain de Place. On the other hand, some bars were broken at points where the apparatus indicated a flaw, but where the metal proved to be perfectly sound; so that the apparatus is not yet quite trustworthy.

**A Twin Screw River Boat.**—The accompanying illustration, from *Le Yacht*, shows a light boat for service on the Mekong River, in Cochin-China, built by M. Dubigeon, at Nantes, France. She is 164 ft. long, 23 ft. wide and 5 ft. 7 in. deep; she draws only 27½ in. of water when fully loaded. The two engines are triple-expansion, made very light, and steam is supplied by two locomotive boilers of steel, built to carry 145 lbs. working pressure; the fuel will be wood. The twin screws work in recesses formed in the after end of the boat, as shown by the dotted lines in fig. 1; fig. 2 is a cross-section showing the arrangement and the form of these recesses.

The boat has two decks, but is provided with very little cabin accommodation, the open decks being preferable in the very hot climate where she is to work.

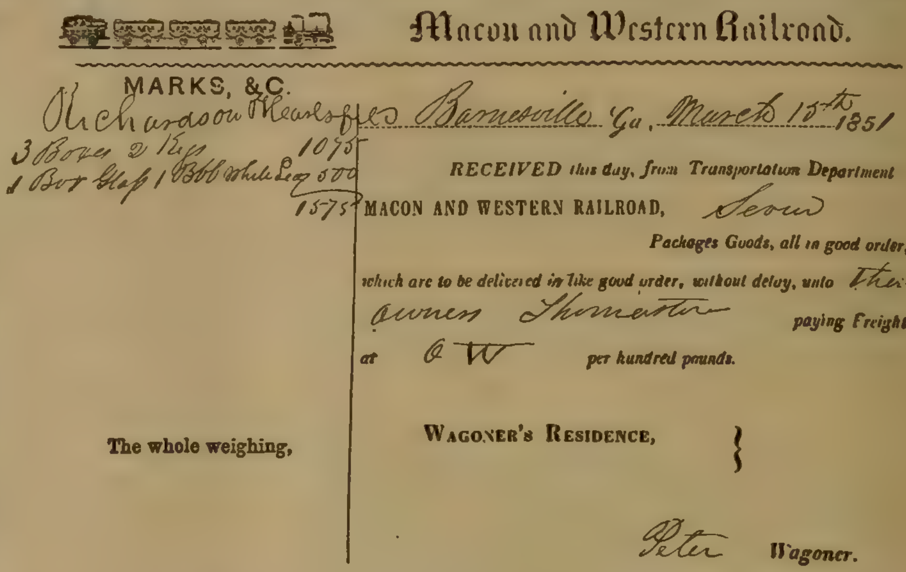



**The Great Pendulum in the Eiffel Tower.**—M. Mascart has recently placed in the Eiffel Tower a pendulum which is certainly the largest ever put up. It consists of a bronze wire 115 meters (377.20 ft.) long, attached to the center of the second platform of the tower and reaching to a point 2 meters (6.56 ft.) from the ground. This wire supports a steel sphere weighing 96 kilogrammes (211.58 lbs.).

It may be noted here that a pendulum was once suspended under the dome of the Pantheon by M. Foucault, and that there has been recently some talk of replacing it there.

There has also been, for some months past, in the tower of St. Jacques, a pendulum extending from the top nearly to the bottom, the weight of which describes its oscillations in the hall on the second story.—*Revue Scientifique, Paris.*

**An Old Time Bill of Lading.**—The accompanying is a reproduction, on a reduced scale, of an old-time document, sent to us by Mr. J. A. Droege, Master of Transportation of the East Tennessee, Virginia & Georgia Railroad, who writes: "The enclosed is a relic of interest, a bill of lading dated March 15, 1851—about 39 years ago—of the Macon & Western Railroad; this is the old name for the Central of Georgia. Barnesville to Thomaston is a distance of 16 miles; my presumption is that the figures in the upper left-hand corner represent weights of various articles, as they would be rather high freight charges, even in that day."



Macon and Western Railroad.

MARKS, &C.

Richardson & Searles Barnesville Ga., March 15th 1851

3 Boxes 2 Kegs 1075
1 Box Glass 1 Bbl White Lead 500
1575

RECEIVED this day, from Transportation Department MACON AND WESTERN RAILROAD, Seven Packages Goods, all in good order, which are to be delivered in like good order, without delay, unto their owners Thomaston paying Freight at 6 cts per hundred pounds.

The whole weighing,

WAGONER'S RESIDENCE,

Peter Wagoner.

The goods, whatever they were, seem to have completed their journey from Barnesville by team, as the wagoner "Peter"—now doubtless gone, with his team—has receipted for them. The document bears marks of age, but is in better shape than might be expected.

**Big Guns.**—Mr. J. H. Longridge, the eminent English mechanical engineer, has written a pamphlet in which he says that with a pressure of 30 tons, and the comparatively short gun he recommends for naval use, the high velocity of 3,000 ft. a second could be easily attained, and he concludes his *brochure* by utterly condemning long guns, and stating his "conviction . . . that guns of a very large caliber are a further mistake," and "that a 9-in. or 10-in. high-pressure gun would be sufficient for any effect that is required against the heaviest armor afloat."

**Population of Japan.**—Official returns show that the population of Japan on December 31, 1889, was 40,072,020—20,246,336 males and 19,825,684 females—who occupied 7,840,872 houses. Subdividing the population into classes, there were 3,825 *Kwazoku* (nobles), 1,993,637 *Shizoku* (middle class), and 38,074,558 *Heimin* (lower class). As against the previous year there is an increase of 464,786 in the population, and of 38,046 in the number of houses. Of the total population 14,890,238 were married and 25,181,782 (12,801,217 males and 12,380,565 females) unmarried.

**A Lake Carrier and Her Work.**—The accompanying illustration, for which we are indebted to the Cleveland *Marine Review*, shows the steamer *Harlem*, belonging to the Western Transit Company, and employed in that company's line between Buffalo and Chicago. This boat left Buffalo for Chicago on her first trip April 8, 1890, and between that time and the close of the season of navigation made 27 round trips, handling in all 102,500 tons of freight, or an average of about 3,800 tons.

The *Harlem* cost $250,000; she was built by the Detroit Dry Dock Company in Detroit.

The smaller illustration, also from the *Marine Review*, shows the steamer *Owego*, which is not only a large carrier, but has the reputation of being the fastest large boat on the lakes.

WESTERN LINER "HARLEM."

**Color Blindness.**—Extensive tests have recently been undertaken in Russia as to color-blindness among the various railway servants. The result was that of 12,542 switchmen, 68 were color-blind; of 4,620 station-masters, 17 were color-blind; of 6,321 machinists, 21 were color-blind, and of 18,000 watchmen on the railways, 140 were color-blind. The various color-blind officials have now been either transferred to occupations where this defect is of no importance, or dismissed.

**The Lansdowne Bridge.**—A description of the bridge thus named, which is one of the great bridges recently completed in India, is given in a paper recently read before the Institution of Civil Engineers in London by Mr. F. E. Robertson. At Sukkur, where the Northwestern State Railway has been carried across the Indus, the river passes through an isolated ridge of nummulitic limestone, and is divided into two channels. The Sukkur Pass is bridged by three spans of 278 ft., 238 ft. and 94½ ft. respectively, while the Rori Channel is crossed in a single span of 820 ft. The steel superstructure of the last-named span was designed by Sir A. M. Rendel, and consists of a pair of cantilevers, each having a projection of 310 ft., carrying between them a central girder 200 ft. in length. The paper was principally a description of the methods employed in the erection of this span. Each cantilever has a vertical height of 170 ft. above the abutment, and at this point the principal members consist of a vertical pillar and an inclined

UNION LINER "OWEGO."

strut or jib, united at the top by a horizontal tie, and tied back by an inclined land-tie or backstay anchored into the rock. When the anchorage had been bedded, the inclined guy and the vertical pillar were erected by means of temporary staging, and were permanently connected at the top. The inclined strut, which is 230 ft. in length, was then built up from the abutment, being laid in its inclined position on staging at the lower end, and further supported, as it progressed, by temporary wire ropes from the vertical pillar. For the erection of the permanent horizontal tie between the tops of the pillar and the strut, a temporary wire rope suspension bridge was thrown across the space of 123 ft. between their summits. This bridge carried a gantry, on which ran the travelers employed in erecting the steelwork of the horizontal tie. The cantilevers on each side of the river having thus been pushed forward with an over-reach of 123 ft., a system of running overhead rope gear was fitted up, spanning the invervening gap, and serving for the erection of the remaining members of each cantilever piece by piece. The ropes were worked from the summit of each cantilever by winches, which were driven by a steam-engine on and by means of a running rope. When the cantilevers had thus been carried out to their full length, the central girder was erected upon a temporary inverted bowstring, which was slung across the opening with the aid of the overhead gear.

**Structural Iron.**—The increase in the use of structural iron in the Northwest is one of the most interesting points in the marvelous development of the section, and is by no means confined to the two or three cities therein which lay claim to metropolitan distinction. In nearly all public buildings and in private enterprises of the more permanent and substantial character, whether they are in towns of a hundred thousand or two thousand inhabitants, more or less architectural iron work is used, and experienced builders say the proportion consumed is quite as heavy in the Northwest according to population as it is in the East. When it is considered that the cities and towns of the Northwest have all been built in a hurry and supposedly with less regard for the element of permanence than the necessity for expedition, the true importance of the fact is plain. As an industry the manufacture of architectural iron ought to

grow very rapidly and keep pace fully with the development of the iron resources of the country.—*Northwestern Mechanic.*

**The Topographical Survey of Connecticut.** — For two years past this survey has been in progress under charge of a Commission consisting of Professor William H. Brewer, of New Haven; James H. Chapin, of Meriden, and John W. Bacon, of Danbury. The work is carried on in co-operation with the United States Geological Survey, and will probably be finished in another year. It will for the first time show the actual size of the State, if the dispute with Rhode Island about the Pawcatuck River boundary can be satisfactorily adjusted in the mean time.

The survey has been made with special reference to the topography of the State, and in this regard the map will be very accurate. Owing to the fact that several of the towns have neglected to mark out their boundary lines, from local disputation or other cause, the subdivisions of the State cannot be marked with the exactitude that was desired; but for this those towns themselves will be the principal sufferers.

The map, which is to be published next year, will show all the contours and delineations of the surface of the land, denote every lake, river, railroad, and highway, and will also show the drainage of each stream that might possibly be used for local drain or sewer work. The map is to be published in 26 sheets, each about 12 × 17 in. A section will represent 200 square miles of surface, averaging about six towns. The scale to be used is 1 to 62,500.

Separate maps will show the divisions of cleared, tillable, and forest lands. A notable fact that has been brought out by this survey is that in the valley through which the Northampton Railroad runs there are no tillable lands above an altitude of 400 ft. between New Haven and Simsbury, a distance of 42 miles, while about eight miles to the west some of the very best farms are 800 ft. or more above the sea level.

**The Washington Heights Viaduct.**—An engineering work of considerable importance is the viaduct on which work is now in progress, and which is to extend from St. Nicholas Place in New York City to Seventh Avenue and 155th Street, close to the southern end of the Macomb's Dam Bridge. The viaduct is 1,600 ft. long, and the difference in height between the two ends is about 80 ft., requiring a uniform grade of 5 ft. in 100. The abutment at St. Nicholas Place, where there is a high rocky bluff rising from the low bank of the Harlem River, will be about 60 ft. in height, the foundation being blasted out from the rocks at the foot of the bluff. The viaduct will be carried from that point to Eighth Avenue on spans of 44 ft., each supported by iron towers rising on masonry foundation. At Eighth Avenue the viaduct will be 48 ft. above the street and some 27 ft. above the elevated railroad, which it crosses at that point. For the remainder of the distance to Seventh Avenue the spans will be 43 ft. each.

The full width of the viaduct will be 60 ft., of which 40 ft. will be a road-bed for vehicles, the remainder being taken up by a 10-ft. sidewalk on each side. Over the elevated station at Eighth Avenue there will be a plaza or platform 80 × 100 ft., from which stairs will descend to the station. The roadway will be made of steel buckle-plates, over which will be placed a layer of concrete, upon which will rest a granite block pavement of the kind ordinarily used in the streets. The sidewalks will be of asphalt. The viaduct is to be completed about a year from the present time. The work now in progress is the construction of the stone foundations for the iron piers.

In connection with this viaduct a new bridge is to be built over the Harlem River, which will be known as the Webster Bridge, and will take the place of the old Macomb's Dam Bridge. The plans for this had been prepared, but some changes have been proposed, and it is not impossible that others will be required, owing to legislation on the Harlem improvement, which will be urged at Albany this winter.

**A Japanese Canal.**—A canal has recently been completed in Japan to connect Lake Biwa with the Kamagawa River and the city of Kioto. This canal is 6.88 miles long altogether, and has on its course some important works. The accompanying illustrations are views on the line, taken for *La Nature.*

The canal has to pass through several ranges of mountains, and this is effected by means of three tunnels, the length of which are 8,040 ft., 411 ft. and 2,802 ft. respectively. These tunnels are of the section shown in fig. 2, and have a breadth of 16 ft. and a height of 14 ft. They are lined throughout with masonry. Fig. 2 shows the entrance to No. 1 tunnel, which is 8,040 ft. long and is the second longest in Japan. At a distance of about 5¼ miles from Lake Biwa the canal is divided into two portions, one joining the River Kamagawa, and the other leading northward to Kogawa, the northern extremity of the city of Kioto. The second portion of the canal, after passing through a tunnel 450 ft. long, crosses the Valley of the Imperial Tombs by a handsome aqueduct, which is shown in fig. 3. This aqueduct is 300 ft. long, and consists of 14 arches of masonry.

FIG. 1.—ENTRANCE TO THE CANAL FROM LAKE BIWA.

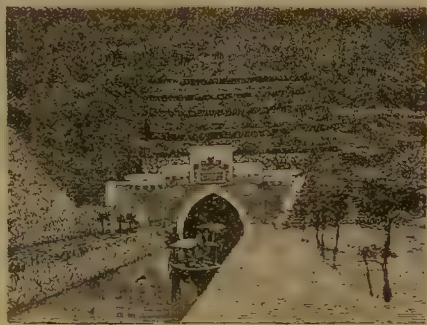


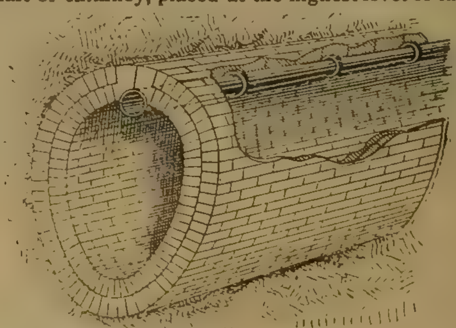
FIG. 2.—ENTRANCE TO NO. 1 TUNNEL

FIG. 3.—AQUEDUCT CARRYING CANAL ACROSS A VALLEY.

Fig. 1 shows the entrance to the canal at the extremity of Lake Biwa. This entrance was formed by reclaiming about 1,000 ft. of the lake, and forming a breakwater to protect it and ensure still water.

The canal serves a double purpose, furnishing a line of navigation, and bringing down the water from Lake Biwa for use in irrigating the lands about Kioto.

**Ventilating Sewers.**—The accompanying illustration shows a method of ventilating a sewer devised by Messrs. A. Ford and E. Wright, and recently tested at Portsmouth, England. It consists in placing a special ventilating pipe in the upper part of the sewer with openings at intervals; at the lower end this pipe communicates with the air, and its other end is in a ventilating shaft or chimney, placed at the highest level of the sewer.



A current of air is induced by forcing a small stream of water through the pipe.

In the sewer where it was tried, which is 47 in. in diameter and about 10 ft. below the surface, the ventilating-pipe is of steel, 5½ in. in diameter and made in lengths of 30 in., with an opening close to each joint. The pipe was fixed to the brick of the sewer by staples driven in.

In a length of 300 ft. selected for the test a water current consuming 3½ cub. ft. per hour was found to cause a current through the ventilator varying from 330 to 380 ft. per minute, according to the amount of water in the sewer, the height of the latter varying from 14 in. to 29½ in. The discharge from the ventilator was from 2,100 to 2,500 cub. ft. per hour, which, allowing for the varying level, was equivalent to a complete renewal of the air in an hour.

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NEW YORK, APRIL, 1891.

ON May 1 the offices of THE RAILROAD AND ENGINEERING JOURNAL will be removed to the new building, Nos. 45–49 Cedar Street. The correct address of the JOURNAL will therefore be, after May 1, No. 47 Cedar Street, New York City.

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THE best method of protecting iron and steel structures from rust is an important question for engineers, and one on which there are wide differences of opinion. In another column a contributor expresses very decided opinions in favor of the use of red lead for this purpose, and gives some very good reasons in favor of his views. Discussion of this question may do much good; and statements of experience in this direction will be very useful. The use of iron and steel in bridges and other structures is now so general that the best protection of the metal against deterioration is a matter which should interest almost every one.

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THE production of Bessemer steel in the United States last year, like the production of pig iron, was the largest on record. The total amount as recorded by the American Iron & Steel Association, was 4,123,535 net tons, an increase of 841,706 tons, or 26 per cent. over the production of 1889. The figures include 76,990 tons made by the Clapp Griffiths process and a small amount by the Robert process.

Of the total production about 60 per cent. was made in Pennsylvania and a little over 20 per cent. in Illinois, the balance being furnished by other States.

The production of steel rails also showed a large increase. It amounted last year to 2,013,188 net tons, an increase of about 22 per cent. over the previous year; that is, nearly half the Bessemer steel produced was converted into rails. The increase in rail production was not quite as great as in the total steel production, the tendency last year being the same as in previous years, the proportion of steel used for other purposes having increased largely for several years past. Rail production has showed a very considerable gain, but has not kept pace with the steel production, a fact which will not surprise any one who knows the continual increase in the application of steel for other purposes, especially in building and architectural work.

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THE special bulletin issued by the Census shows in a striking way the increase in the production of anthracite coal. In the Census year 1889 the production was 40,665,000 long tons, against 25,576,000 tons 10 years ago. The total shipments of anthracite for the 10 years 1870–79 were 195,714,000, and for the 10 years 1880–89, they were 315,523,000 tons, showing an increase of over 50 per cent. in the average for the 10 years. Anthracite shipments are apt to be somewhat variable every year, owing to various causes which are well understood by the operators, so that the 10 years' average affords the best basis for comparison. According to the information collected by the Census there are 342 coal breakers and collieries in operation in the anthracite region, but as the average number of days' work is not over 200 in the year, it appears that the production is much below the possible maximum.

An addition to consumption, which is seldom taken into account, is the amount now drawn from the culm-banks of the various collieries. A considerable quantity of small coal and coal dust, which was formerly thrown away upon the bank, is now utilized, and the banks which have accumulated at many collieries are continually being drawn upon. In time, probably, all of this waste will be utilized, when the increasing cost of mining will make it profitable to put in the necessary appliances.

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THE Census report of the Maryland coal product, which includes chiefly that of the Cumberland and adjoining regions, does not show much increase, the output for the last Census year being 2,940,000 short tons, against 2,229,000 tons 10 years ago. The production last year, however, was considerably less than in 1888, owing chiefly to lack of transportation. The coal of the Cumberland region is almost entirely used as a steam coal, owing to its peculiar qualities and high reputation, and most of it goes Eastward to tidewater, a great deal being used by sea-going vessels, while large quantities are carried by water to the Eastern States.

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PROBABLY no industry included in the Census will show greater increase between the 10th and 11th Census than coal mining in Alabama. The preliminary report gives the total production of the State last year at 3,378,000 tons, while 10 years ago it amounted only to 324,000. A large part of this production was used at home by the furnaces and other manufacturing establishments, but considerable shipments were made to other States, and an increasing amount finds its way to tidewater for export, chiefly to the West Indies, or for steamship use.

There are three well-known coal districts in Alabama, the Warrior, the Coosa and the Cahaba fields, including a total area of about 8,700 square miles.

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THE amendment to the Interstate Commerce law, which was passed by Congress at its last session, gives the Commission power to require the attendance of witnesses, production of books, and such other information from common carriers, subject to the law, as may be required to enable the Commission to perform its duties. Attendance of witnesses may be required from any place in the

United States to any designated place of hearing, and the orders of the Commission may be enforced by the United States Circuit Court. The Commission also receives the usual powers in relation to taking depositions, etc., the appointment of deputies and other necessary powers. This is an amendment which the Commission has been trying to secure for some time as necessary to the proper execution of its work.

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THE process of railroad consolidation still continues, the latest step made being the lease of the Rome, Watertown & Ogdensburg Railroad by the New York Central & Hudson River Company. By this lease the lessee adds some 700 miles to its system, and secures control of a road which might be used to some extent as a competitor for traffic, though most of its business has always found an outlet over the Central's line. The lease seems to have been forced upon the Rome Company by the threat of a competing line for its most profitable traffic, but the terms are sufficiently favorable to the stockholders, who are guaranteed dividends equal to those they have been receiving lately, after a suspension of several years.

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THE New York Central Company is credited with further plans for increasing its system, by controlling the New York, Ontario & Western, which has never been a profitable line. The Central might be able to work it to better advantage, and the union would do away with some competition. It is also reported that the Central would like to secure control of the Delaware & Hudson Canal Company's lines in Northern New York. That company is a strong one, however, and much of its stock is owned by wealthy and influential men. It has generally worked very harmoniously with the Central, and it is possible that the rumors of a lease are not well founded in fact.

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THE success attained with the Weems electric railroad, on a somewhat imperfect experimental track with a small car, has led to the formation of plans for a larger road, supplied with an electric locomotive and cars of sufficient size to carry passengers. Mr. O. T. Crosby, the consulting electrician, who has prepared the plans, believes that with a properly constructed track and a locomotive of sufficient size a speed of 150 miles an hour can be reached without difficulty.

The experiments made with the small car on the Weems system seem to mark this as the most promising plan for fast travel on an electric road yet brought forward. The speed attained is limited by the defects of the track used, but it is said to have reached 115 miles an hour.

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THE latest proposition for an addition to the Chicago Exposition is made by Mr. C. W. Hastings, of Kansas City, who proposes a tower 1,000 ft. in height. It is, however, to be directly the reverse of the Eiffel Tower, as instead of having a broad base and tapering gradually to the summit, the base is to be small, about 20 ft. in diameter, while at 800 ft. above the ground, the diameter will be nearly 200 ft. In other words, it will very much resemble the Eiffel Tower upside down. Its stability is to be secured by huge stays or guy-ropes stretched in all directions, and upon the summit will be a summer garden, gymnasium, dining-room, etc.

Should any of the guy-ropes give way, it is to be feared that this extraordinary structure would not be in a position to support the hotel and other establishments on its top very long, especially if there were any wind blowing. Moreover, there are some slight difficulties in the erection, which Mr. Hastings does not seem to have taken into account.

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THE Naval appropriation bill, as finally passed, makes provision for only one new vessel, a protected cruiser of 7,300 tons displacement and 21 knots speed.

Other special appropriations include $100,000 for tests of armor; $100,000 for traveling cranes at the New York and the Norfolk yards; $136,889 for the new Naval Observatory, and $25,000 for the naval militia.

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THE bill authorizing the Government to guarantee $100,000,000 bonds of the Nicaragua Canal Company failed to pass Congress, owing to lack of time. It will be brought forward again in the next Congress.

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THE plan adopted for stirring up public opinion on the highway question by the Engineering Association of the South is to have short, pointed, practical papers, to be printed and widely distributed. This seems to be an excellent way; the greatest difficulty will be at the beginning—to secure suitable papers.

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THE chief value and purpose of the diplomatic service of the United States is to help and forward its commercial interests abroad, and consequently its manufacturing interests at home. The State Department has done some very good work in this direction, and the consular reports which it issues contain much valuable information. The more credit is due to the Department for what it has done, when it is remembered that under our present system it has too often to make the best possible use of very inefficient agents.

Under these circumstances, it is not at all encouraging to find a person appointed to the very important position of Minister to China, whose sole recommendation is that he is a politician "out of a job." Personally the new minister's character may be unexceptionable, but he is certainly far from being fitted for a post which, beyond any other in our diplomatic service, requires a shrewd, capable, active man of affairs. China is just beginning, through many struggles, to recognize the necessity of building railroads, and of adopting modern methods of mining, modern appliances in manufacture, and modern ships. The process is a very slow and difficult one at best, but there is progress, and at this juncture the services of a capable man, with some knowledge of Chinese affairs and the national character, might be of inestimable value to American manufacturers and engineers. Such a man could be found; there are a few names that will suggest themselves to any one who thinks on the subject; but "politics" have been too much for the appointing power, and our interests must suffer accordingly.

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THE Japanese Government has resolved upon a large increase of its navy, the policy being to promote shipbuilding at home as much as possible. Considerable additions have already been made to the navy, and the Japanese mercantile marine is growing rapidly, but the home shipyards are still insufficient in capacity to construct a num-

ber of war-ships. The programme recently adopted provides for 25 new ships, including battle-ships, fast cruisers and coast defense batteries. The first to be bought or built during the current year will be two armored cruisers and three torpedo boats, all of which will be procured in Europe, and a similar addition will be made every year for the next four or five years. These new ships will bring the Navy of Japan up to 75 vessels, of which about 40 will be of the most modern construction.

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THE Navy Department has already sent out a call for bids for the construction of Cruiser No. 13, the only new ship authorized by Congress at the last session. The plans are not yet completed, but it is stated that they will follow closely those of No. 12, the fast three-screw cruiser now building at the Cramp yards, in Philadelphia. The new ship will have three screws, a sea speed of 21 knots an hour, and will be of 7,400 tons displacement. She will be a fast cruiser, with large coal capacity and consequent long cruising range, and with comparatively light armament. The bids will be opened in June.

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THE "whale-back" steamer *Colgate Hoyt*, which was described and illustrated in our columns some months ago, has developed another good quality in addition to those already claimed for her by her builders. On her last trip down for last season her captain reports that she proved herself a first-class ice-breaker, the peculiar form of her bow working away and breaking up easily the ice which was forming rapidly on the lake as she came through.

The whale-back ships are to be tried on the ocean as well as on the lakes, one being under construction which is to be sent through the canals to the Atlantic. This boat will be employed in carrying iron ore from Cuba to the United States.

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THE two steel steamships which were built last summer in the Wheeler Yard at Bay City, Mich., for the coasting trade, have been successfully brought down to Montreal and will soon be ready to take their places on the Atlantic. As they were too large to pass the St. Lawrence Canals, the novel plan was adopted of cutting them in two and sending them down in sections to Montreal, where the halves were joined together. The bulkheads were arranged with a view to this, and the trip was made without accident of any kind.

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THE Intercontinental Railroad Commission is making arrangements for preliminary surveys of the proposed line through Central America, which is to connect the Mexican railroad system with the railroads of South America, and to form a link in the great Intercontinental line. Several parties will shortly be put in the field, and the Secretary of War has detailed a number of Army officers, who will be employed in this work under the general direction of the Commission.

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THE latest accounts from Russia are to the effect that work is to be begun this year on the Siberian Railroad, and that six years are to be allowed for the completion of the work. This covers only the sections surveyed, of which a very full account has been given in the JOURNAL, leaving open the two long stretches covered by water navigation, which are to be replaced by railroad lines later. There is little doubt, however, that the western section, from Chelabinsk to Tomsk, will be supplied with a railroad before the central section is finished, since the work of construction itself will show the difficulty of relying on a long and circuitous river line in that country.

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## THE CENTENNIAL OF PATENTS.

THE first American Patent Law, entitled "*An Act to Promote the Progress of the Useful Arts*," was signed by George Washington on April 10, 1791. In view of the results of this wise legislation it is proposed to celebrate the event by a series of public meetings to be held in Washington on April 8, 9 and 10, an announcement of which will be found on another page. An inviting list of eminent speakers is announced for that occasion, who will discuss the history and the advancement of the patent system and its influence on science, art and progress generally. The celebration will be profitable if it does nothing else excepting to elucidate to the public the extent to which the advancement and prosperity of the country and its people, has been and is due to our patent system.

The Constitution of the United States very wisely provided that Congress shall have power "to promote the progress of science and useful arts by securing, for limited times, to authors and inventors, the exclusive right to their respective writings and discoveries." The wisdom of doing this is, however, still disputed by a great many people; and the patent system has many enemies in Congress and out of it. The recent discussion of the International Copyright Bill by our national legislators and in the newspapers, has revealed how confused the ideas of many people are with reference to property in ideas. More than thirty years ago Herbert Spencer wrote: "That a man's right to the produce of his brain is equally valid with his right to the produce of his hands, is a fact which has yet obtained but a very imperfect recognition." "The sense of property," it is said by an eminent writer on law, "is inherent in the human breast; and the gradual enlargement and cultivation of that sense, from its feeble force in the savage state to its full vigor and maturity among polished nations, forms a very instructive portion of civil society." The recent adoption of the International Copyright Bill, and a celebration of the beginning of the patent system, are certainly interesting and instructive epochs in the gradual enlargement and cultivation of the sense of property. Perhaps no fitter words could be found for promulgating the celebration of the anniversary of the signing of the first American patent law than those of Chancellor Kent in his "Commentaries on American Law," in which he says: "It has been found necessary, however, for the promotion of the useful arts, and the encouragement of learning, that ingenious men should be stimulated to the most active exertion of the powers of genius in the production of works useful to the country and instructive to mankind, by the hope of profit, as well as by the love of fame or a sense of duty. *It is just that they should enjoy the pecuniary profits resulting from mental as well as bodily labor.*"

In other words, the Government said, in effect, one hundred years ago, that, in order to stimulate invention, it would secure to inventors, for a limited time, the right to the exclusive use and profit of their productions and discoveries. Quoting Herbert Spencer again, "there are philanthropic and even thinking men who consider that the valuable ideas originated by individuals—ideas which

may be of great national advantage—should be taken out of private hands and thrown open to the public at large." This spirit has manifested itself very strongly among the granger farmers of the West, and is common among some manufacturers, and frequently crops out in attempts at legislation. There are many people who hold that to allow the discoverer of any new or improved mode of production to have the exclusive use of his invention is an injustice. The question is constantly recurring, Why should a person who first invents or discovers a new and useful art, machine, manufacture, or composition of matter, have rights secured to him which are denied to another, who is the second inventor, and who may invent or discover the same thing an hour, a day, or a year later? The answer to this is, that unless such rights are secured to inventors they will stop inventing, or, in the language of the eminent author from whom we have already quoted: "Just in so far as the benefits likely to accrue to the inventor are precarious, will he be deterred from carrying out his plans. 'If,' thinks he to himself, 'others are to enjoy the fruits of these wearisome studies and these numberless experiments, why should I continue them? If, in addition to all the possibilities of failure in the scheme itself, all the time, trouble and expense of my investigations, all the chances of destruction to my claim by disclosure of the plan, all the heavy costs attendant upon obtaining legal protection, I am liable to be deprived of my right by any scoundrel who may infringe it in the expectation that I shall not have money or madness enough to institute a chancery suit against him, I had better abandon the project at once.' And although such reflections may often fail to extinguish the sanguine hopes of an inventor, although he may still prosecute his scheme to the end, regardless of all risks, yet after having once suffered the losses which, ten to one, society will inflict on him, he will take good care never again to enter upon a similar undertaking. Whatever ideas he may then or subsequently entertain—some of them most likely valuable ones—will remain undeveloped and probably die with him. Did mankind know the many important discoveries which the ingenious are prevented from giving to the world by the cost of obtaining legal protection, or by the distrust of that protection if obtained—were people duly to appreciate the consequent check put upon the development of the means of production—and could they properly estimate the loss thereby entailed upon themselves, they would begin to see that the recognition of the right of property in ideas, is only less important than the recognition of the right of property in goods."

In all probability many of the most important inventions which have been made, and which are used in recent years, would either never have been developed, or would have been delayed for years had there been no patent laws to protect the inventor while he was working out his ideas. Among these are the Bessemer processes of making steel, continuous brakes, interlocking and block signals, to say nothing of the electric telegraph, the locomotive itself, and thousands of minor inventions through or by which the whole art of railroading has been built up. Without steel rails and tires the cost of carrying freight would be very much increased, and the perfection of the signals and brakes alone makes the immense traffic of some of the crowded lines possible, or at any rate makes it possible with comparative safety.

The question is constantly recurring, Why should a person who first invents or discovers a new and useful art, machine, manufacture, or composition of matter, have rights secured to him which are denied to another who is the second inventor, and who may invent or discover the same thing an hour, a day, or a year later? It would be well if the critics of the patent system would consider the probable effect of repealing the patent laws, and the result which would follow if the Government should refuse to secure to inventors the exclusive right to their inventions. The purpose of the patent law is to "*stimulate* ingenious men," and that it accomplishes its purpose the weekly issue of patents testifies.

A preliminary programme of the celebration sets forth that distinguished speakers will show the influence which invention has had in Household Economy; Medicine, Surgery, and Practical Sanitation; Electrical Science, Material Development of the United States; Railroads and other means of Intercommunication; Chemistry and Physics; the New South; Implements and Munitions of Modern Warfare; Telegraph and Telephone; the Steam Engine, Agriculture, and the Relation of Invention to Labor.

In the interest of the patent system, it is to be feared that sufficient evidence to prove the converse of the general proposition, embraced by these subjects, will not be brought forth. That is, the opponents of the patent system will say, all this development and progress is not the result or consequence of our patent laws, but it has been evolved by the forces of our civilization, and this advancement would have occurred as rapidly without patents as with them. It is difficult, however, to conceive of any other motives, excepting the prospect of the enjoyment of pecuniary profits, which would be sufficient to lead most persons to suffer the ills which most inventors must endure. "Fame," or "a sense of duty" might lead some to invent, and others might engage in the somewhat expensive and absorbing diversion from a mere love of it; but few would be sustained to endure the rebuffs, the failures, the discouragements, the expense, the ridicule often, the loss of time, and the uncertainty which nearly all who carry an invention to a successful issue, are subjected. A little experience of the difficulties which must be encountered would soon cool the ardor of the most ingenious men, if the exclusive right to the use of their inventions were not secured to them. It is a very common experience for persons of an inventive turn of mind to conceive of some new idea, and to discover that it is old, or has been anticipated, and therefore is not patentable. The alacrity with which such conceptions are abandoned is strong evidence in favor of patent laws.

It is probable that few persons have any idea of the extent to which the success of a new invention is dependent upon the zeal, enthusiasm, faith, hope and perseverance of the inventor. It is rare that a new machine or discovery springs full-fledged, or, rather, full-pinioned, from the mind or hand of its author. Usually his offspring is a puny and ungainly chick, which requires to be long and carefully nourished with paternal hope and affection, and needs time for development before it is of much use. It is only a parent who will give such care, and without it any infant is likely to perish.

It must be remembered, too, that the world is not eager in welcoming new inventions. Generally the inventor must fight his way. He must overcome ignorance, selfishness, and the depressing mental inertia which blocks the way of all progress, and will not move excepting under the

blows of some intellectual battering-ram. It is in this direction that the inventor does much of his most useful work. He necessarily becomes a sort of missionary to preach progress, and convert those who do not believe in it; and many a valuable discovery would never be adopted were it not for the efforts of its discoverer in teaching and convincing others of its value. Few men are sufficiently unselfish to engage in such work without the hope of pecuniary profit, and this is supplied by our patent laws.

## HIGHWAY ROADS.

THE agitation of the highway question is active in Tennessee, where it has been taken up by the Nashville Commercial Club—a body of considerable weight and influence—and active measures have been taken to impress upon the people the value of better roads. Much of this activity is due to the persistence and intelligence of one man (Professor O. H. Landreth, of Vanderbilt University), and his success is an instance of what may be accomplished in this direction. After all, the advantages of good roads are so manifest, that it seems as if all that is really necessary is to make the people at large understand them, in order to secure at least a beginning of the needed reform.

The bill which the Nashville Club has prepared for submission to the Legislature has as its basis the adoption of the county instead of the road district as the highway unit, and this is supplemented by a system of State supervision. That the larger district is necessary to secure proper management there is little doubt. The county can afford to secure the services of an engineer where the little road district must depend on such time as an overseer can spare from his other work; moreover, even if he wants to do well—which is not always the case by any means—he is usually unacquainted with the proper methods of building and maintaining roads. Too often the district officer cares only to get along with as little trouble as possible, and to keep on good terms with his neighbors by making their road tax as light as possible.

The great trouble is just here—to make farmers and land-owners understand that their nominal road tax, under any system, is a trifling one compared with the continual tax imposed on them by bad roads. They do not pay this in money, but it is none the less real and onerous. There is hardly a county in the United States where a good road system would not increase the value of farming lands; and but little calculation is needed to show how much an increase of 20, or even 10 per cent. in the load which his team can haul over a road would benefit the farmer. This is a gain which can be realized every day in the year almost, so that its total must be considerable even for the smallest farmer.

Some advance in the highway question is to be noted elsewhere than in Tennessee. In New York a bill to carry out Governor Hill's recommendation of a system of State roads is before the State Legislature, and has a fair chance of passing. In New Jersey the county system is beginning to show its advantages in those counties where it has been adopted, so that others are preparing to follow their example. In Pennsylvania the agitation continues, and some action may be taken this year on the recommendations made by the Road Commission.

Agitation is needed everywhere; and much can be accomplished by local bodies like the Nashville Commercial Club. But this must be supplemented by instruction in the best methods of building and maintaining roads; not theoretical, but practical, with regard to local conditions and the greatest economy consistent with good work. This can be done in many cases by the local engineering associations; and there is no more useful work which they can undertake than to follow the good example set by the Engineers' Society of Western Pennsylvania, and the Engineering Association of the South.

## NEW PUBLICATIONS.

THE DURABILITY OF BRICK PAVEMENTS. By Professor Ira O. Baker. (T. A. Randall & Company, Indianapolis; price 25 cents.)

Engineers in Eastern cities, where stone is accessible and usually cheap, do not realize to how great an extent brick is used for street pavements in the Mississippi Valley and other parts of the West where suitable stone is not to be had, or where it must be brought long distances and is, therefore, costly. In this little book Professor Baker has given the results of a number of experimental tests made by him with a view of determining the value of brick for street pavements, as compared with stone, wood and other materials. The results were more favorable to brick than had been expected; but they agree with those obtained by practical tests in St. Louis and other cities.

THE COAL TRADE. *A Compendium of Valuable Information Relative to Coal Production, Prices, Transportation, etc.* By Frederick E. Saward. (*The Coal Trade Journal*, New York.)

This is the eighteenth number of Mr. Saward's valuable annual, which is what its title indicates, a valuable compendium of statistics relating to the coal trade of this country, with incidentally a good deal about the same trade in other countries.

COMPOUND LOCOMOTIVES. By Arthur T. Woods, M.M.E. (R. M. Van Arsdale, New York.)

This book is a republication of a series of articles which first appeared in the *National Car and Locomotive Builder*, in the preparation of which the Author says it has been his aim "to combine the description of the various forms of compound locomotives which have been actually used, with so much of the theory of the design of compound engines as would seem to be directly applicable to locomotive practice.

"An effort has been made to present an unprejudiced analysis of each type, and to point out such advantages and disadvantages as are apparently clearly demonstrable, while carefully avoiding matters of individual preference."

This purpose the Author has very fully accomplished; and he has made a little book of 167 pages, from which more information on this subject can be obtained than from any other one source. The literature on the subject is scattered very widely, and is difficult of access to the ordinary reader, so that a compilation, or rather condensation of it, like the book before us, is very much needed. In doing his work, however, the Author did more than compile and condense—he *digested* his material, and has presented it in clear and concise style, so that any one with an elementary knowledge of algebra can read it understandingly.

The first chapter treats of the theory of compound engines; the second of the design of two-cylinder compound locomotives; the third of the Worsdell von Borries System; the fourth of the Mallet two-cylinder type; the fifth of the Lindner

type; the sixth of the economy of two-cylinder engines; the seventh of three-cylinder engines; the eighth of the starting power and performance of three-cylinder engines; the ninth of four-cylinder receiver engines; the tenth of four-cylinder tandem engines; the eleventh contains a comparison of types, and the twelfth and last chapter is on American compound locomotives.

There is little that is new in the book; but this is not written in disparagement of it, as it is intended, apparently, only as a summary of the existing knowledge on the subject.

A table opposite page 82 shows, from tests with simple and compound locomotives in different parts of the world, an economy in fuel consumption varying from 13 to 24 per cent. The highest percentage of saving was for a six months' trial of two engines in Saxony, working with the same boiler pressure —176.4 lbs. in each engine, which otherwise were of almost identical dimensions. In another case the pressure in each engine was 120 lbs., with a saving of 13.5 per cent.

In speaking of the Webb compound locomotive the Author says: "The weak features in its design, from an American point of view, have been charged to the compound system in general, and its successes credited to the personal superintendence or 'nursing' of the inventor. That the latter is a factor which is at least worth considering in estimating the value of reported results, should be evident to all who are familiar with the management of steam machinery." We are inclined to think that this remark should apply to the recorded performances of all engines whatsoever—simple as well as compound—and not to the Webb engine alone.

There is much cumulative testimony, showing the economy in fuel consumption of compound over simple locomotives, but not more than there was a few years ago to show the economy of narrow-gauge railroads over those of standard gauge. It was the friends of the narrow gauge who testified then, it is the friends of the compound locomotive who are giving evidence now. The arguments, and the gauge, which were then believed in so earnestly, have both been narrowed into nothingness. It may be well, perhaps, to sift the evidence in favor of compound locomotives very carefully now, rather than to be led into a demonstration as expansive as that which was needed to refute the narrow-gauge delusion.

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VALVE GEARS. By H. W. Spangler, P. A. Engr., U. S. Navy; Whitney Professor of Mechanical Engineering in the University of Pennsylvania. (John Wiley & Sons, New York.)

The Author of this treatise says that it was prepared for class use, which accounts, perhaps, for the liberal employment of mathematics in its pages. It may be well for purposes of discipline and training of students, to explain subjects by methods more difficult to understand than the matter explained, but to a person accustomed to practical work it seems a circuitous way of reaching an end to which there is a more direct and shorter road. Take, as an example, the following formula, which is given on page 54, for calculating the distance a valve, moved by a Stephenson link, travels from its middle position:

$$x = \frac{r}{2\,c}\left(2\,\frac{c^2-u^2}{g}\cos.\,\delta\cos.\,\omega + 2\,c\,\sin.\,\delta\cos.\,\omega + 2\,u\cos.\,\delta\sin.\,\omega\right)$$

$$= r\cos.\,\omega\left(\sin.\,\delta + \frac{c^2-u^2}{c\,g}\cos.\,\delta\right) + \frac{u\,r}{c}\cos.\,\delta\sin.\,\omega.$$

Would any engineer of experience ever use such a method to ascertain the distance a valve has moved?

Then two very simple movements of the valve are explained by means of the Zeuner diagram, which is not always easy to understand. Besides, in one place, it is admitted that in deducing the equation for the Zeuner diagram, certain approximations have been made which cause the diagrams to be more or less inexact. In other words, after puzzling the student with difficult elucidations, it is admitted that neither are correct.

The book treats of different kinds of valves and methods of designing them—the Stephenson link, the Gooch motion, the Allen and Fink motions, radial gears, including Hachworth's, Marshall's, Angstrom's and Joy's; double and gridiron valves, Polonceau's, the Buckeye, Meyer's and Guinette's gears, and Bilgram's, Releaux and elliptical diagrams.

The book gives a description of the construction and principles of action of all these different kinds of gears, which doubtless will be useful to those students who are well up in mathematics. To most practical men who are not mathematicians, the explanations and solutions will be hard to understand. In nearly all cases, probably, books are written and published to sell. Whether this was the object or not in issuing the one reviewed here is not apparent from the copy before us; but there can be little doubt that its field of usefulness would have been much wider if the subjects discussed had been treated graphically also, and if difficult mathematics had been ignored.

The book is deficient, too, in not explaining more fully what should be accomplished by a valve-gear. To get a complete understanding of this, valve-gear must be studied in connection with, or rather in relation to, indicator diagrams. In doing this it should be known first what kind of indicator diagrams ought to be produced by a valve gear. In other words, the first question to be considered is, what should be the forms of indicator diagrams to produce the best results in using steam in engines of different kinds, and next, how should the gear be designed and proportioned to produce such diagrams?

Considerable space is devoted to explaining how the slip of the link-block may be reduced. This slip, it is said, is objectionable if excessive, which may be doubted. As a matter of fact, the slip of the block in a Stephenson or Gooch link, and, probably, in other gears, may be a very useful means of modifying the action of the gear in order to accomplish certain desirable results; and if there are ample bearing surfaces, it really matters very little whether the slip is much or little, excepting so far as the action of the gear on the motion of the valve is concerned. The use which may be made of the slip of the block is not explained.

The book before us will be very useful as a class book in the hands of its Author or other teachers, but it is rather a book for the study than an elucidation of the subject of valve-gears for practical men.

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FOURTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION. *For the Year* 1890. (Government Printing Office, Washington.)

The fourth report of the Interstate Commerce Commission is necessarily, to some extent, a repetition of what has been said before. The work of the Commission is varied, but, after all, it presents a certain monotony, and it is necessary to present the same subjects year after year, and to repeat the same recommendations in order to secure the attention of Congress. That body is too apt to neglect modest claimants and, like the unjust judge in the parable, listen to those who weary it with constant asking. Four years' experience with the interstate commerce law has naturally shown its weak points and the provisions which need to be changed or abolished, but it is no easy matter to secure these changes from the legislative body.

The statement of the work done for the year, and of the practical workings of regulation, shows that the Commission is a hard-working body, and has little opportunity for idleness.

Apart from this statement, the subjects treated of in this report are Rate Wars and Rate Cutting; Reasonable Rates; Uniform Classification; Long and Short Hauls; State Regulation; Foreign Regulation of Railroads; Ticket Brokerage; Through Routes and Through Rates, and Payment of Commissions on sales of Tickets.

The report recommends some needed amendments to the act, and gives a condensed statement of the methods adopted in the different States. Appended to the report is an account of the Conference of Railroad Commissioners, and also a chapter on Railroad Regulation in Foreign Countries.

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HANDBOOK OF THE AMERICAN REPUBLICS. *Bulletin No.* 1 *of the Bureau of the American Republics, January,* 1891. (Washington; Government Printing Office.)

One of the results of the Pan American Conference at Washington last year has been the establishment of the Bureau of the American Republics, which has its headquarters in Washington, and the object of which is to collect and distribute information of interest and value to the commercial public of American countries, the end in view being the improvement and development of commercial intercourse.

The present Bulletin No. 1 must be regarded as preliminary, and in fact an introduction to the series. It is what its leading title indicates, a handbook of condensed information as to lines of communication between the United States and the Republics of Central and South America; commercial systems and trade customs of the different countries; commercial laws and tariff systems; productions, imports and exports; present condition of trade; coinage and monetary systems; consular regulations; and a variety of geographical information.

Necessarily in a volume where condensation and brevity is an object there is no opportunity for literary display; but the information here is clearly and plainly given. Its value is much increased by a very full index. The statistics and other information are brought up to the latest possible date. Altogether the book must be a very useful one to those for whom it is intended, and it is an excellent beginning of a promised series.

## TRADE CATALOGUES.

*The Johnson Railroad Signal Company's Catalogue: Rahway, N. J.*

The word catalogue does not indicate correctly the character of this volume. An elementary and abridged treatise on railroad signaling would describe it better. The object of the pamphlet, as stated in the introduction, is "to draw attention to the appliances of the Iohnson Railroad Signal Company, and to give a few hints on signaling in general."

It explains very briefly the best methods of protecting switches, side-tracks, grade-crossings, draw-bridges, single and double-track junctions, and passenger stations with signals. These explanations are followed by remarks on the arrangement of tracks, the number of levers which should be used, selectors, dwarf signals, and a description of the Johnson interlocking machine.

The pamphlet will be found very useful to all who are interested in signaling, but especially to those railroad men who have little or no knowledge of interlocking signals. It can be read in less than an hour, and it contains the recommendations of one of the most expert signal engineers in this country.

The office of the Johnson Signal Company is at 146 Broadway, New York; the works are at Rahway, N. J.

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*The Norwood Car Replacer Company, Baltimore: Illustrated Catalogue.*

*Rosendale Cement; its Uses and Modes of Application: by Ludlow V. Clark, Jr. New York; the Lawrence Cement Company.*

*Treatise on Cement: by M. Albert Scull. New York; the Lawrence Cement Company.*

## BOOKS RECEIVED.

*Proceedings of a National Convention of Railroad Commissioners held at the Office of the Interstate Commerce Commission, Washington, D.C., March* 3 *and* 4, 1891. Washington.

*Annual Report of the State Board of Arbitration of Massachusetts, for the year* 1890. Boston; State Printers.

*Annual Report of the Board of Regents of the Smithsonian Institution.* Washington; Government Printing Office.

*Annual Report of the Smithsonian Institution; the United States National Museum.* Washington; Government Printing Office.

*The American Patent System; a Practical Guide to the Inventor and to the Investor in Patents; by D. Walter Brown.* New York; published for the Author.

*Reports of the Consuls of the United States to the State Department: No.* 123, *December,* 1890. Washington; Government Printing Office.

*Eighth Annual Report of the Board of Railroad Commissioners of the State of New York, for the Fiscal Year ending June* 30, 1890. Albany, N. Y.; State Printer.

*Occasional Papers of the Institution of Civil Engineers.* London, England; published by the Institution. The papers included in this issue are Steam on Common Roads, by John McLaren; Mental Calculation, by W. Pole; Tramway Permanent Way, by James More, Jr.; Abstract of Papers in Foreign Transactions and Periodicals.

*Transactions of the Denver Society of Civil Engineers and Architects: Volume I,* 1890. Denver, Col.; published for the Society.

*Nineteenth Annual Report of the Superintendent of Water-Works, Bay City, Mich.: E. L. Dunbar, Superintendent.* Bay City, Mich.; published by the City.

*Annual Register of the United States Naval Academy, Annapolis. Academic Year,* 1890–91. Washington; Government Printing Office.

*Cornell University, College of Agriculture: Third Annual Report of the Agricultural Experiment Station.* Ithaca, N. Y.; published by the University.

*Municipal Ownership of Quasi-Public Works: by Allen R. Foote;* printed for the Author. This is a reprint of a paper read by Mr. Foote before the Washington Branch of the American Economic Association.

*Reform in Railway Construction: by Oberlin Smith.* Reprinted from the *Forum* for the Author.

*Annual Message of Chas. M. Howe, Mayor of the City of Passaic.* Passaic, N. J.; printed for the City.

*Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending September* 30, 1890. Washington; Government Printing Office.

## ABOUT BOOKS AND PERIODICALS.

APART from teachers and others whose interest in the subject is professional, there are certainly a large number of persons in this country who take much interest in geographical studies. The periodicals issued by the geographical societies contain many valuable papers, but these are often too long for a man who has his daily work or profession to attend to; and their circulation is necessarily limited to the members of the societies and their immediate circle.

To meet this want, Messrs. M. & J. C. Goldthwaite, of New York, began in January the publication of GOLDTHWAITE'S

GEOGRAPHICAL MAGAZINE, a monthly, intended to present new facts ascertained; descriptions of new apparatus and methods; accounts of explorations, surveys, etc., and other geographical notes. These are given in condensed and popular form, and the articles are well illustrated. The Messrs. Goldthwaite have been for years in the geographical publishing business, and are consequently familiar with the subject and its general range, while they have means of acquiring the latest information.

The three numbers of our geographical contemporary which have been thus far issued are excellent, and give promise of future usefulness in their chosen field. The articles are varied in subject and treatment, but all are short, and show marks of careful condensation. A number of them are illustrated. Mention of them separately would require more space than can be allowed here, but one of the most interesting is the leading one, on the Mapping of the World. There are in the magazine 72 pages of reading matter, besides cuts, the page being slightly larger than that of *Harper's* or the *Century*. The typographical execution is good, and altogether the magazine deserves the success which we hope and believe that it will secure.

The February number of the JOURNAL of the American Society of Naval Engineers contains articles on Forging Steel Crank Shafts, by Assistant Engineer A. M. Hunt; Fitting the Crank Shaft of the *Newark*, by Passed Assistant Engineer A. C. Engard; Causes of the Vibrations of Screw Steamers, by Assistant Naval Constructor D. W. Taylor; Register for Speed Trials, by Assistant Engineer W. D. Weaver; Trial of the *Concord*, by Chief Engineer R. B. Hine; Trial of the *Newark*, by Assistant Engineer L. D. Miner; Experiments with the Belleville Boiler, by C. A. Blomberg. In this number also, Chief Engineer Isherwood criticises the recent paper on Analysis of Steam-Engine Trials, by Assistant Engineer W. H. Allderdice, and the author defends his position against Mr. Isherwood's criticisms.

There will be found in BELFORD'S MAGAZINE for March the usual variety of lighter matter, and several more solid articles. This is the only one of the prominent magazines having a decided political cast, and its articles on political topics are generally moderate in tone and well considered in argument, making them worth reading, whether we agree or disagree with the conclusions drawn by the writers.

The December number of the JOURNAL of the New England Water-Works Association has papers on Water Supply for Small Cities in the West, by Wynkoop Kiersted; Filtration of Natural Waters, by Professor Thomas M. Drown; Variations of Weather and Climate as Affecting Water Supply, by Professor William R. Niles. There are also discussions on several topics of interest to water-works engineers.

The military article in OUTING for March describes the training of the British Red-coat, and is well illustrated. Shipbuilders should study Captain Schuyler's paper on the Evolution of the Yacht. Summer in the Azores and Winter in North Carolina, find descriptions in this number, while canoeing, photography, fishing, and duck-shooting all have their share of attention.

The November number of the TECHNOLOGY QUARTERLY has an article on the Changes of the Year, by General Francis A. Walker, besides a number of other papers of technical interest. This is largely a chemical number, the longest articles being on questions relating to technical chemistry, although other subjects are touched on also.

The South American paper in HARPER'S MAGAZINE for March describes the city of Buenos Ayres; it is accompanied by a number of illustrations. Nationality in Music is a curious study, and might be enlarged to show how the musical tendencies of a people complement its more material qualities. Among the lighter articles, a story by Brander Matthews illustrates the capacities of a modern "vestibule limited" train.

The fourth article on American Industries, which is given in the POPULAR SCIENCE MONTHLY for March, continues Mr. Durfee's series on Iron Working, and is on rolling and forging iron. Professor Ordway's paper on Non-conductors of Heat, is an excellent one, as is also that of Relative Value of Cements, by Professor C. D. Jameson and Hubert Remley. Adaptation to Climate, by M. St.-Yves Menard, and the Cultivation of Sisal in the Bahamas, by J. I. Northrop, are interesting articles.

The January number of the SCHOOL OF MINES QUARTERLY has papers on the Coal-Fields of Montana, by Walter H. Weed; on the U. S. Geological Survey, by H. M. Wilson, besides several other papers of special value to mining engineers. The News Bulletin ought to be of much interest to the Alumni of the School.

In its March number the ECLECTIC MAGAZINE has an excellent selection of articles from the foreign magazines. Among the more noticeable are Englishmen in Africa, from the *Contemporary Review*; Trade Unionism, from the *Nineteenth Century*; Weighing the Stars, from the *Gentlemen's Magazine*, and the Cost of a London Fog, from *Leisure Hours*. This magazine is an excellent one for all who wish to know something of the foreign periodicals, but have not the time or opportunity to read the originals. Its selections are generally judicious, and are made to show the general current of thought and writing abroad.

The leading paper in the March number of the JOURNAL of the Military Service Institution is on Artillery Administration, and is by the late General Henry J. Hunt, whose distinguished service as Chief of Artillery of the Army of the Potomac are well remembered. Other articles are on Musketry, by Captain Chester; on Military Gymnastics, by Captain Foote; on the Increase in the Number of Cadets, by Professor Michie, and on the Power of the Senate, by General Foy. The usual variety of reprints and translations completes a very interesting number.

The latest quarterly number of the PROCEEDINGS of the United States Naval Institute is devoted to the Armor Tests at Annapolis. There is a short introduction by Edward W. Very, and the report of the Board is given in full, with numerous illustrations. These tests were of high value, and nothing of greater interest could have been presented at the present time.

In the March number of SCRIBNER'S MAGAZINE, Samuel Parsons, Jr., writes of the Ornamentation of Ponds and Lakes, of which he is well qualified to speak, from his long experience as Superintendent of the New York parks. Mr. M. B. Kerr describes Mount St. Elias and its glaciers, and Sir Edwin Arnold's papers on Japan are continued. The views of Mount St. Elias are very striking, and praise must be given also to the illustrations in the paper on London and American Clubs, which are excellent; those of the Japanese paper, however, are not as clear in execution as the designs deserve.

The contents of the LEHIGH QUARTERLY for January include Lehigh University Precise Triangulation, by Henry S. Jacoby; Development of the Coal and Timber Lands of Southeastern Kentucky, by F. E. Fisher; Emery Wheels, by J. S. Heilig; a series of short articles on Civil Engineering, including advice to young engineers, by Alfred P. Boller, O. Chanute, Horace Andrews, W. Barclay Parsons, and F. C. Osborn.

As usual, the March ARENA is full of discussions of social and other topics. Among these may be mentioned Professor Buchanan's paper on Nationalization of the Land, and Rabbi Schindler's on Immigration. The description of a curious people, whose origin is unknown, but who still survive in an out-of-the-way corner of Tennessee, which is written by Miss Drumgoole, is a valuable contribution to minor history. The ARENA is combative and aggressive, and no one can read it without finding some new ideas.

## A NEW BRIDGE-GUARD.

(M. J. W. Post, in *Revue Generale des Chemins de Fer.*)

THE importance of some device to prevent injury to bridges from the derailment of cars on the approaches, hardly requires discussion. The expense of any such device is usually small in comparison to the total cost of the bridge, and the greater the number of trains, the less should such cost be considered.

A bridge-guard, or rerailing device, should meet certain general conditions, which may be summed up as follows:

1. It must be so arranged that it cannot in any way cause the derailment of a car. It should, therefore, leave abundant room for the passage of wheels, making all allowances for the condition of wheels and tires when badly worn, as well as when new. Account must also be taken of the occasional use of cars from other roads.
2. It must not touch the weak points of a derailed car, and must be so arranged as to come in contact with the running gear only.
3. It must direct the wheels of a derailed car back upon the track without violent shocks, either in a horizontal or a vertical direction, and must bring them back before they reach the bridge.
4. It must keep on the track during the passage of the bridge cars which may have been derailed from any defect.
5. It must be constructed of durable materials, and in such a way that it will not be likely to fail when needed.
6. It must have no very heavy pieces, so that its putting in place, repair, etc., can be easily done by an ordinary track gang.
7. It must permit the tamping of the ties.
8. It must be cheap to make, to put in place, to keep in order and to renew. In other words, it must be easy to handle, and of small cost.

The accompanying illustration shows an apparatus which is in use on the Netherlands State Railroads, and which, it is believed, will meet all these requirements. It is very clearly shown in the engravings.

Seven ties are placed in a thick bed of large gravel ballast, and on these are placed a floor of steel plates, fastened to the ties by bolts, as shown in fig. 2. The rerailing apparatus is mounted on this floor. The plates outside of the rails can easily be removed when the ties are to be tamped.

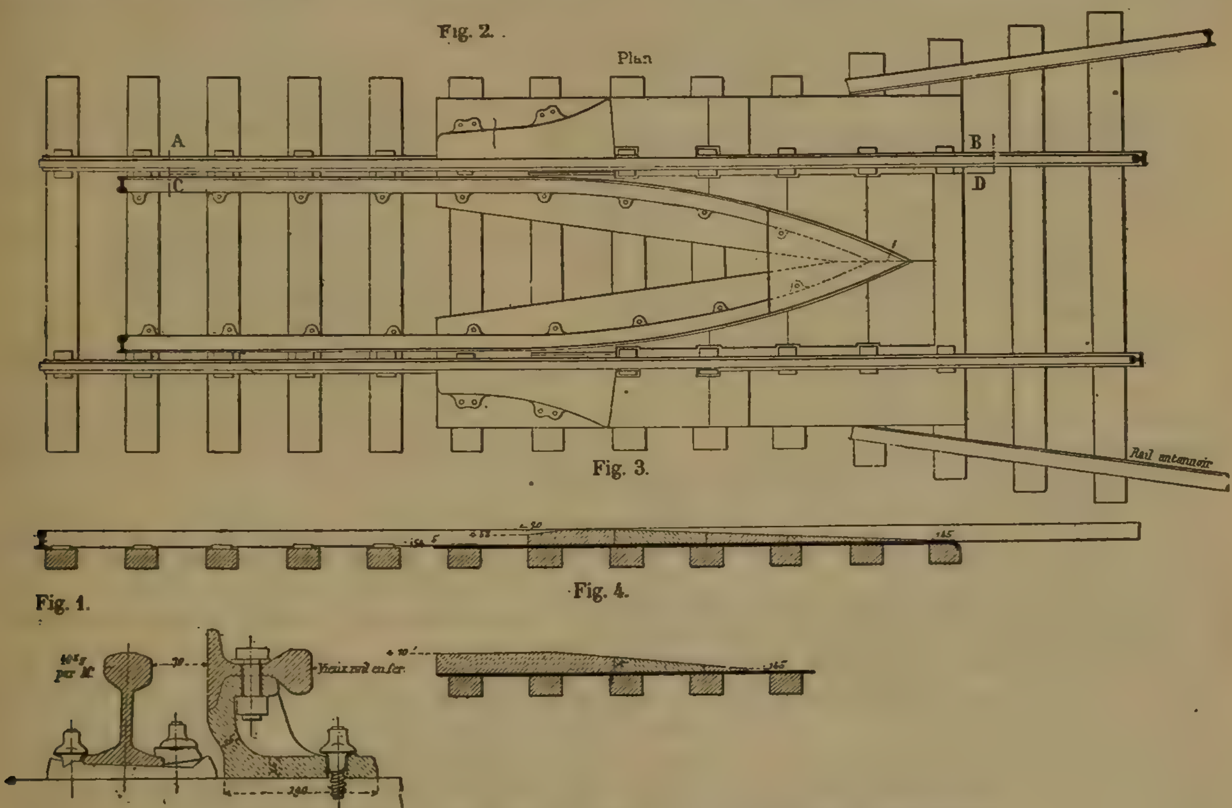
In a vertical direction, the derailed wheels are gradually brought up to a height where they can take the rail again by inclined planes outside and inside the rail; these planes are formed of blocks attached to the plates, the thinner ones being forged and riveted, the heavier ones cast and bolted. These are shown in section in figs. 3 and 4; fig. 3 is a section on the line *C D*, fig. 2, inside the rail, and fig. 4 is a section on the line *A B*, outside the rail.

A derailed wheel which strikes this plane between the rail and the center of the track, running from *D* toward *C*, on the flange of the wheel, at the point where the horizontal distance, fig. 2, between the rail and the guard-rail becomes too small to permit the passage of the widest tires—say 6 in.—is already at the top of the incline plane, that is, about 0.8 in. below the top of the rail. As the depth of the flange may vary from 1 in. to 1.38 in., the tread of the wheel will be at least 0.2 in. above the top of the rail. The plane then descends slightly, as shown in fig. 3, until the tread of the wheel begins to bear on the rail.

On the inside of the rail the blocks are from 2.8 in. to 4 in. distant from the rail, so as to give free passage for the flanges of those wheels which remain on the track.

A derailed wheel, which reaches the apparatus outside the rails, rolling from *B* toward *A*, will mount the plane, traveling on the flange. The summit of the inclined plane might be made the same height as the rail, if it were necessary to provide only for new rails and new tires; but to allow for worn rails and tires it is made 0.4 in. lower than the top of the rail.

In a horizontal direction one wheel on each axle of a derailed car is directed toward its rail by a guard-rail, which ends in a point in the center of the track, as shown in fig. 2, and which, to meet condition No. 4, is carried the whole length of the bridge, leaving a space of 2.8 in. to permit the passage of the wheel flanges. This guard-rail is composed of old rails bolted to chairs, as shown in section in




BRIDGE-GUARD IN USE ON THE DUTCH STATE RAILROADS.

fig. 1. The points of the guard-rails are joined by a heavy plate. In view of the space allowed, and of the maximum wear of rails permitted, the top of the guard-rail is 1.4 in. above the top of the rail; at the point it is brought down to 0.43 in. below the top of the rail, to meet condition No. 2.

In a case where a car is so far off the track that one of its wheels would strike the rerailing apparatus beyond the center of the track, the tendency would be to throw the wagon entirely off the rails. To avoid this, which indeed cannot often happen, there are placed outside of the track two rails, inclined like the mouth of a funnel, as shown in fig. 2, which will guide the wheel in the desired direction, so that it will strike the guard-rail and be turned toward its own rail.

A single-track bridge, where trains run in both directions on the same track, will, of course, require the rerailing apparatus at each end, and the guard-rails will unite the two. On a double-track bridge one rerailing apparatus will be placed on each track on the end from which the trains on that track approach the bridge. Each track will then be supplied with guard-rails, which are finished off at the opposite end by a curve.

The point of the rerailing apparatus should be placed whenever possible at a distance of from 100 ft. to 170 ft. from the end of the bridge.

## HOW TO HANG BRAKES.

At the last meeting of the Southern & Southwestern Railway Club, a paper on this subject was presented by Mr. J. J. Casey, Superintendent of Motive Power, Louisville, New Orleans & Texas Railroad, which called out a discussion in which the ideas presented by Mr. Casey were generally approved. The paper is given below:

After careful consideration, I believe that the proper place to hang the brakes is to the trucks, and not to the car body. The brakes should not only be hung from the truck, but from a rigid portion of the truck. If they are hung to the top bolster of the truck they will vary in their relation to the center of the axle, according to the load in the car and the depression of the springs; their position then depends entirely on the amount of vertical motion there is in the bolster springs, thus making it a difficult matter to keep the slack adjusted in the brake-rods. This would be particularly objectionable where air-brakes are used.

In arriving at my decision I have also been influenced by the fact that, when set, the tendency of the brakes hung to the body is to keep the trucks on a line with the body, instead of with the track. On improperly constructed curves, or bad track, this must necessarily be a source of accident, since the relations between the trucks and the car body are not compensating; in other words, the body will not allow the trucks to accommodate themselves to the variations in the track as would be the case if the brakes were hung from the truck.

Brake shoes should engage the wheel as near a central line as practicable, having the greater portion of the shoe below the center line of axle. If hung too low the brake shoe on one end of the truck (depending, of course, on the direction in which the car is moving) will form a wedge in addition to the adhesion given to it by the rod; the result is slid wheels. My experience would seem to show that there is very little difference, as regards safety, between brakes hung to the body of the car and brakes hung to the truck; this is due, I think, to the fact that no records on the subject are available.

Another point to be considered, one that does not seem to have been touched upon, is that hanging the brakes to the body materially shortens the life of the car. The car bodies are built, as a rule, to carry a certain load; no provision is ever made for the additional strain that is put on them by the braking power. This strain is considerable, and every one knows it is very irregular, and must necessarily be very destructive to the body, owing to the fact that those strains are at least five feet from the center of the transom, this of itself giving considerable leverage. I do not consider it to be more expensive to maintain brakes hung from the trucks than those hung from the body. It is a very rare occurrence for us to have cars in our shop requiring repairs to inside brakes.

When brakes are hung to the body, I have noticed frequently that sills have been split and otherwise damaged in wrecks on account of the trucks leaving their place and being held to the body by the brake hangers only; something has to give way, and usually it is the sills.

This subject is of great importance, and should not be passed over lightly. There is a good deal that might be said, and I trust that it will have one effect—to cause members of this club to look more closely at the matter in the future. Possibly, some time later on this subject may be brought up again, when a great many of our members may be able to throw a good deal of light on the safety of brakes hung to the trucks versus those hung to the body.

## THE DEVELOPMENT OF THE COMPOUND SYSTEM IN LOCOMOTIVES.

By M. A. Mallet.

(Paper read before the Société des Ingenieurs Civils, Paris; translated from the French by Frederick Hobart.)

(*Continued from page* 112.)

In conclusion, it may be said that the argument of want of stability which has been advanced against the two-cylinder type of compound locomotive by a number of engineers, seems to be fully contradicted by experience, and by the fact that there are now over 700 locomotives of this type in use, a number of them being run regularly at very high speeds.

The last two-cylinder type which we will illustrate, is given in figs. 21, 22, and 23, which show an engine built for the Jura-Berne-Lucerne Railroad, and which was shown at the Paris Exposition.

### THREE-CYLINDER COMPOUND LOCOMOTIVES.

The first idea of a compound locomotive of the three-cylinder type made public was by my colleague, M. Jules Morandiere, in a letter published in *Engineering*, in 1866. In this, which described an engine proposed for the Metropolitan Railroad, in London, there were two groups, each having two axles coupled, the one worked by a single cylinder, the other by two. The first cylinder was the high-pressure cylinder, and the two others the low-pressure cylinders.

While studying, at Creusot, the engines built for the Bayonne-Biarritz Railroad, M. Andrade, then Engineer in the Navy and stationed at those works, proposed to use instead of two cylinders of different sizes, three cylinders, one in the center receiving the steam, the two others outside to be the low-pressure cylinders. These were to work on the same axle by cranks set at an angle of 120°. A starting valve similar to that of the Biarritz engines, but worked by a small steam cylinder, would permit the engine to be used either as a simple or a compound engine.

About the same time a Swiss engineer, John Moschell, proposed the use in locomotives of steam jackets and of a compound system with two cylinders. In reply to this I published an article supporting the two-cylinder type, or if the power of the machine should render that insufficient, a four-cylinder type, with the cylinders placed in tandem and working on the same crosshead. As I said at the time: "If the engines are not actually too heavily loaded at the start, we will be able at a very small expense to put them into condition to work much more economically, or even by using direct steam in the large cylinders to increase the power from 20 to 30 per cent., always on condition that the adhesive weight remains in proper proportion to the tractive effort. This would be easy to obtain in a number of engines where the axles do not carry more than from 9 to 10 tons."

This was a rational solution, and was adopted by the Northern Railroad of France, just 10 years later, on its eight-wheeled coupled locomotives.

The first three-cylinder compound engine which was put in actual operation was built in 1888, by Struwe, at Kolomna, in Russia. The three cylinders, the high-pressure in the center and the two low-pressure outside, worked on the same axle, the first by a central crank and the others by crank pins outside set in the same position, and at an angle of 90° with the central crank. This is the same as Mr. Webb's first arrangement, for which, however, he can claim priority, as his design was made public in June, 1879, while the German patent taken out by Struwe for his engine is dated in October of the same year.

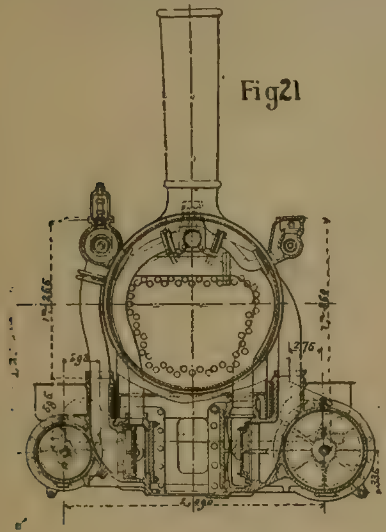


Fig 21

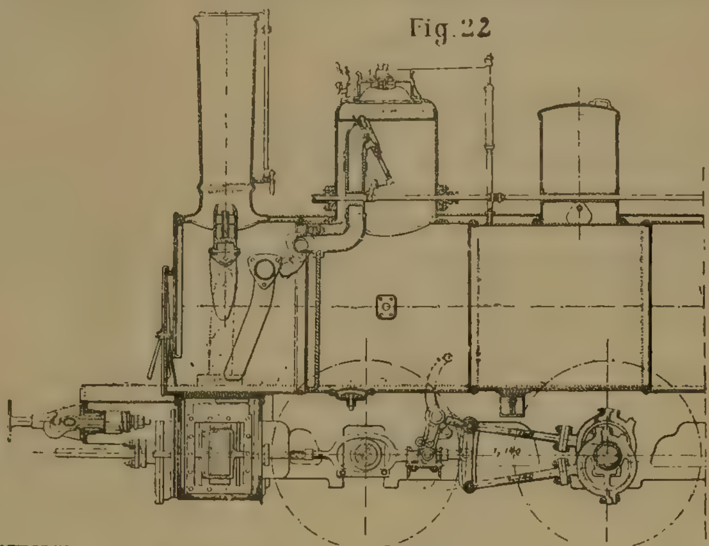


Fig. 22

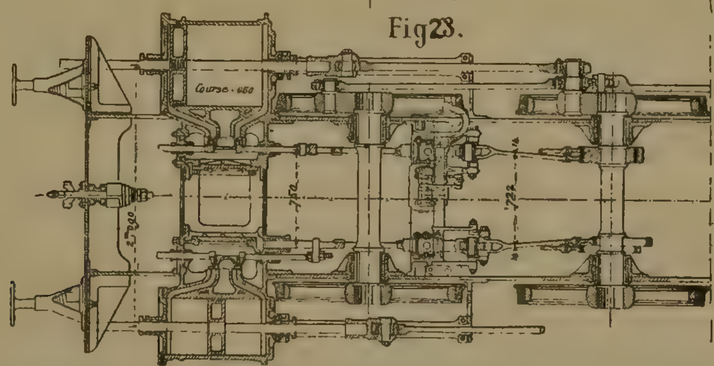


Fig 23.

It is probable that the results from this engine were not favorable, since very little has been said about it.

At the end of 1881, Mr. F. W. Webb originated his celebrated type by building the engine *Experiment*—No. 34 on the table. Mr. Webb was convinced of the advantage of compound working, and wished to make an engine for high speed after the three-cylinder model of Stephenson, by causing the steam to work, in the first place, in the outside cylinders, and then in the central cylinder, the former working on crank-pins set in the same position, and at right angles with the central crank of the axle. This, he believed, would make an economical type, and one which would be very satisfactory at high speed. Mr. Webb hoped also to obtain a supplementary advantage by doing away with parallel rods, and making the high-pressure cylinders work upon one axle and the low-pressure upon another, the two axles being coupled only by the steam, if such an expression is allowable. To attain this object he was not afraid to use a single cylinder to run one axle.

This type, which has received some modifications in detail without changing its essential character, has been brought by its author to a high degree of perfection, and has been received with great favor by his admirers.

Nevertheless, it has required all the ability and perseverance of Mr. Webb—to which no one can do more justice than myself—to obtain good results from a type essentially defective, since it rests in part on an erroneous principle, the use of an axle worked by a single cylinder in a locomotive. The inherent defect of this type is not only in the fact that, if in starting, this cylinder happens to be at the dead point, it cannot assist in starting the train. There is another defect, perhaps much more serious, which has not been before indicated.

This is in the excessive variation in the moments of rotation around the driving-axle produced by the use of a single cylinder, in comparison with two cylinders having a total equivalent section and working on crank-pins placed at right angles.

Calculating these moments from the indicator diagrams obtained by Mr. Webb, and published by him, for running at full admission, say about 70 per cent. in the small cylinders, and for running at an admission of 35 per cent. in the same small cylinders—that is to say, at low speed and at high speed—first, for the axle worked by the large cylinder, and then for the same axle if it was worked by two cylinders of equivalent section acting upon crank-pins at right angles, we obtain the following results for the tangential strain at the circumference of the driving-wheels:

| | Full Admission. | | Admission 35 per cent. | |
|---|---|---|---|---|
| | 1 cylinder. | 2 cylinders. | 1 cylinder. | 2 cylinders. |
| | kgs. | kgs. | kgs. | kgs. |
| Average tangential effort. | 1.818 | 1.818 | 0.586 | 0.586 |
| Maximum " " | 3.437 | 2.500 | 1.330 | 0.833 |
| Minimum " " | -0.150 | 1.450 | 0.200 | 0.500 |
| Difference........ | 3.587 | 1.050 | 1.530 | 0.333 |
| Ratio of maximum to average effort........... | 1.89:1 | 1.38:1 | 2.27:1 | 1.42:1 |

If we compare the case of a single cylinder and that of two cylinders joined, we find the following:

| | Full Admission. | Admission, 35 per cent. |
|---|---|---|
| Ratio of maximum efforts | 1.37 | 1.60 |
| Ratio of differences | 3.43 | 4.59 |
| Ratio of maximum to average efforts | 1.37 | 1.60 |

In the general equation of the movement of the locomotive,

$$p \frac{d^2l}{D} \overset{=}{<} P.$$

As $p$ is an average pressure, we take $f$ sufficiently far from unity to be sure that, except in very unusual conditions, the moving impulse at the rim of the wheels will not exceed the adhesion $f P$, and it can evidently be taken so much greater as the variations of $p$ above the average are considerable.

If we compare the tangential efforts found above with the weight represented by the driving-axle of the Webb engine, indicated at 14,413 kg., or 14.2 tons, we find the following results :

| | Full Admission. | | Admission, 35 per cent. | |
|---|---|---|---|---|
| | 1 cylinder. | 2 cylinders. | 1 cylinder. | 2 cylinders. |
| Adhesion for average effort | $\frac{1}{7.9}$ | $\frac{1}{7.9}$ | $\frac{1}{24.59}$ | $\frac{1}{24.59}$ |
| Adhesion for maximum effort | $\frac{1}{4.19}$ | $\frac{1}{5.76}$ | $\frac{1}{10.84}$ | $\frac{1}{17.54}$ |

At full admission, then, the adhesion falls to $\frac{1}{4.19}$ for an average adhesion of $\frac{1}{7.9}$, necessary with one cylinder, and to $\frac{1}{5.76}$ for the average adhesion with two cylinders ; hence, from the point of view of adhesion, the two-cylinder engine can exercise a tractive power of

$$\frac{7.9}{5.76} = 1.375$$

in ratio to the single-cylinder ; this is a gain of about 40 per cent., or an improvement of 20 per cent. for the complete machine.

In stationary engines we overcome the variation of the moment of rotation by the use of fly-wheels of greater or less weight. In the locomotive, the driving-wheels act to a certain extent as fly-wheels, but in the Webb engine we have only a single pair of wheels, the rims and tires of which have not sufficient weight to regulate the force of rotation below a certain speed, which a very simple calculation shows to be, in round numbers, equal to 150 revolutions per minute, or a speed of 56 km. an hour. Below this speed the tangential effort will be periodically greater than the adhesion, and will lead to a slipping, which can only be prevented by making the large cylinder do a relatively small share of the work ; and this is what happens in the Webb engine.

It is hardly necessary to say that we cannot take into account the weight of the engine and that of the train to supplement the insufficiency of the fly-wheel formed by the driving-wheels, since the only relation which their mass has with the driving-wheels is through coupling. It is a case analogous to that of a stationary engine where the fly-wheels would be placed on a shaft worked from the crank-shaft by means of a belt or friction pulleys. It would be otherwise with the engine on a rack-rail road, where the advance would be produced without any possible slipping on the track.

This difficulty disappears when the speed is considerable. The machine is then essentially a fast running machine, but until it attains the number of revolutions indicated above, it passes through a very unfavorable period. It is not so much the uncertainty in starting as the irregularity of the motion of the driving-wheels during the time necessary to obtain the maximum speed allowable.

The objection which we are striving to develop can be illustrated in a very simple way in the following manner : The locomotive *Dreadnought*, of the Webb type, has a large cylinder 0.762 m. in diameter, or 4.560 sq. m. in section. A pressure in the reservoir of 4 kg. per square centimeter, which would be necessary for the proper utilization of the steam, represents an effort of 18,240 kg., which, reduced at the circumference of the driving-wheels for the position in the middle of the course, would give

$$18,240 \times \frac{0.305}{0.95} = 18,240 \times 0.321 = 5,855.$$

This for a load of 15 tons on an axle would give a coefficient of adhesion of $\frac{1}{2.56}$. It would evidently be necessary to deduct the friction and the resistance of the engine proceeding from other causes, such as the obliquity of the crank, but their effect is not excessive. With two cylinders having the same total section as the single cylinder the effect would decrease one-half and the coefficient of adhesion would become double, that is, $\frac{1}{5.12}$, which is much more desirable.

With a single cylinder one is obliged, before attaining the normal speed, to reduce by a prolonged admission, decreasing the pressure in the intermediate reservoir, the share of the work done by this cylinder, a condition which, besides leading to a faulty utilization of the weight and of the machinery, leads to a very unequal division of the fall of temperature between the two groups, which, as well as the loss in pressure, causes us to lose part of the advantage of the compound working.

To utilize this difference Mr. Webb has, in some engines intended for special service, coupled a second axle to the axle worked by the high-pressure cylinders. The engine is then in better condition to start a heavy train, but there is hardly sufficient reason for preserving the compound working, since the unequal division between the cylinders of the fall of pressure and temperature is not a condition favorable to it.

It would be more rational in these engines to couple the additional axle to that worked by the low pressure cylinder in such a manner as to increase the regulating mass, and thus to permit us to utilize all the work which that cylinder can develop, if we could find a convenient arrangement for that purpose.

The Webb engine escapes with difficulty this dilemma, that it is not able to utilize the adhesion properly at low speed, and that at high speed the advantage hardly justifies the complication. It simply replaces the coupling-rods by a large cylinder and the complete mechanism attached, which is certainly a rather expensive way.

To return to the general arrangement of the machine, which should be well understood, I do not deny that the position of the cylinder in the longitudinal axis of the engine will secure excellent conditions of stability at high speed. This would be a most excellent idea if it did not involve inconveniences which more than balance its advantages.

Mr. Webb evidently knows well the weak point of his machine, and there is perhaps a sign of some modifications in his ideas in the patent taken out by him in 1888, the claims of which are the combination in the locomotive of two groups of cylinders in such a way that both can be worked by direct steam from the boiler or one by the steam from the boiler and the other by the exhaust steam from the first ; second, the use of the arrangements described in the patent to secure this object, and third, the *coupling* of the wheels worked by the different groups of cylinders.

It is hardly necessary to observe that this coupling would only be necessary if one of the groups is composed of a single cylinder. If there were two there would be no necessity for it. We will see further on some engines of this class which are entirely free from the criticism which has been made on the Webb engines.

Before quitting this subject a word must be said of the arrangement opposite to that of Mr. Webb, and that is the use of one high-pressure cylinder and two low-pressure ones, which has been presented by several persons, and which has been said to be a considerable improvement on the Webb engine. This assertion is based upon the greater ease of starting with the two large cylinders, on the smaller size of each of them, and on the possibility of having three cylinders of equal size and of working with direct steam in all three. We do not attach much importance to this change. Its most apparent advantage, the use of three cylinders of equal size requiring only one pattern of pistons, etc., loses much of its importance if we consider that then the ratio between the high and low-pressure cylinder will be only 1:2, unless we employ different strokes—a ratio which it is desirable to exceed with present pressures. With this method we would not be able to utilize the adhesion properly, and in starting it would always be necessary to employ the group which has two cylinders. This would require the use of the low-pressure cylinders in starting always with the direct steam from the boilers, which would involve a certain complication. In any case this movement would not at all do away with the inherent fault of the three-cylinder plan, that of having one cylinder to work one axle.

The only remedy is to double this cylinder, but then a three-cylinder engine—No. 37 in the table—has certainly been built on the plan indicated at the beginning of this chapter and worked out by M. Sauvage, Engineer of the Northern Railroad. This engine presents some very interesting details of which we have not space to speak further here. It seems, however, that this is rather an experiment than a type intended for adoption in current practise.

FOUR-CYLINDER COMPOUND ENGINES WITH TWO MOTIONS.

This first-class of four-cylinder compound engines was presented in my paper of 1877, as having four cylinders disposed in groups, each composed of a primary cylinder and an expanding cylinder placed tandem with a single valve motion for the pair. This system, with details well studied out, especially for the passage of the common piston-rod between the two cylinders, appears the most practicable for heavy locomotives, where the employ of a single low-pressure cylinder would require dimensions inadmissible in practise. This is probably the plan which has been most often proposed; it has the advantage of preserving the symmetry of the engine, and has against it only the appearance of complication, but this has been enough to prevent its use so far. It is probable that when we shall be more familiar with the principles of the compound working in the locomotive we will not be afraid to use four cylinders whenever necessary.

I cannot now modify essentially this statement, which I wrote 12 years ago.

The first trace which I have been able to find of the use of four cylinders applied to a compound locomotive is in a study made in 1860 by Mr. Ebenezer Kemp, which he has sent to me. This plan, which is shown in figs. 24, 25, and 26, has the title "Proposed Arrangement for Compound

Fig 24. Fig 26

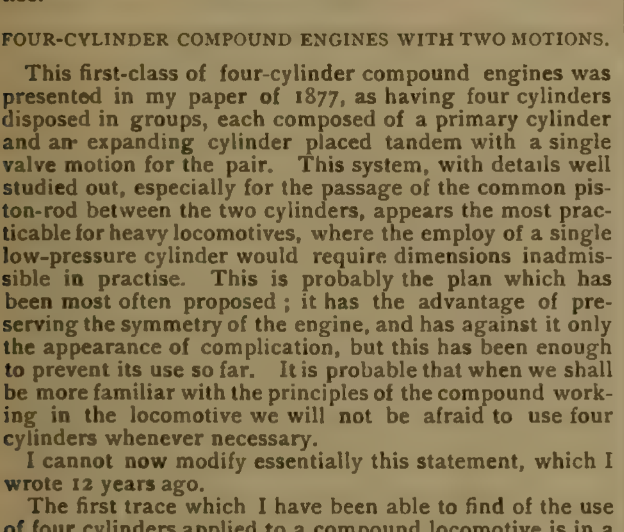


Fig 25

Locomotive Engine," and is dated February 13, 1860. It represents an alteration intended to be applied to an engine on the Caledonian Railroad by substituting for each of the existing cylinders a group of two arranged as indicated above. This arrangement is very carefully studied out and the inconveniences arising from the use of interior stuffing-boxes is lessened by the fact that the parts which they separate have not to undergo simultaneously extreme pressure. On the other hand, the plunger form for the high-pressure pistons allows us to give the waste space an importance which it should have in the corresponding cylinders in order to prevent exaggerated compression. The arrangement of the single valve is very ingenious, but we might criticise the space occupied by the plungers, which makes it necessary to increase the diameter of the cylinder and the surfaces in contact with steam.

The first published document in which mention is made of a four-cylinder compound locomotive is a patent of William Dawes's, dated June 20, 1872, No. 1,857. This patent gives four remarkable arrangements. The first is an engine with cylinders placed in tandem; the second is a four-cylinder engine, each pair being composed of a large and a small cylinder working on crank-pins placed at an angle of 180°, an arrangement which seems to have been used up to the present time only in exceptional cases, and which makes very satisfactory conditions of equilibrium. The third form is an engine in which the two small cylinders work one axle, and the two large ones another without the intervention or use of coupling-rods. The fourth part of the invention covers a detail which is very interesting, since it has recently been applied in Germany on a large scale. This is "a valve putting the steam-chests of the large cylinders in communication with the boiler at will for starting, working, or similar circumstances, this valve being worked by the reverse lever or any part of the valve motion connected with it in such a way that it will only open when this lever is in its extreme position, either forward or backward, and will be closed in all other positions. In this way no danger can arise from the use of this valve."

As I have already said, this arrangement has been recently reproduced by Herr Lindner, and is used on a number of compound locomotives on the Saxon State Railroads.

The form with cylinders placed in tandem has been later proposed by M. de Diesbach, by my colleague, M. Jules Garnier, and by others. As M. Polonceau proposed, I had in 1879 presented an arrangement of this class in order to facilitate the lateration of existing locomotives.

The first tandem engine built, at least for railroads, seems to have been a locomotive of the Boston & Albany Railroad, built in 1883, the results obtained from which showed only a very moderate economy, not sufficient to pay for the expense of maintenance. This was followed by the Nisbet engine, on the North British Railway, and that of Mr. Dean, of the Great Western, in England, which I have not thought necessary to reproduce here. It is not the same in the case of the Woolf engine, with eight wheels coupled, on the Northern Railroad of France, which was worked out by M. du Bousquet.* I will not enlarge upon this type, which is perfectly rational in principle and which agrees with my own plans made in 1877. The only criticism to be made here relates to the increase in size of the large cylinders, the ratio of which with the small cylinders —1:3—seems to me excessive.

The advantage obtained by so great a prolongation of the expansion of the steam would be more than absorbed by the friction, and especially by the increase of surface offered for condensation by the cylinders and the pistons. I speak here of the surfaces in contact with steam, and I have had the curiosity to ascertain what this was for different compound locomotives so far built. This volume is that of the large cylinder multiplied by the ratio of the stroke and the diameter of the driving-wheels. The most rational term to which it has seemed possible to refer for comparison is the adhesive weight. On the other hand, it seems fair to reduce the value thus obtained to a uniform pressure, 140 lbs., for example, since we should wish to obtain an expansion as much longer as the pressure of the boiler is higher. We will thus calculate the value $\frac{D'^2 l}{DP}$, and also that of $\frac{d'^2 l}{DPp}$; in these formulas $d'$ being the diameter of the large cylinder, if there is only one, or the diameter of a fictitious cylinder equivalent to the sum of the sections of the large cylinders, if there are more than one.

* This four-cylinder engine of M. du Bousquet was illustrated and described in the JOURNAL for March 1889, page 127.

We have thus obtained the coefficients given in the last columns of the large table. It will be seen that the Woolf engine of the Northern Railroad presents the ratio of 8.42, while this ratio is only occasionally over 6 in compound locomotives, and for the same pressure of 143 lbs. It descends as low as 2.96, but the most general value is between 4 and 5. It is true that with the increase to 170 lbs. pressure, the figure for the Woolf engine is reduced to 7, which is more reasonable, but still much higher than for most of the other engines. It is only just to say that the ratio of volume of the cylinders of 1:3 was probably not deliberately adopted, but was a consequence of the plan adopted for joining the pistons of the two cylinders by double rods, which requires a considerable relative difference between the diameters of the two cylinders. This method is simple enough, but I do not know to what point this quality of simplicity can compensate for the inconveniences proceeding from so great an increase in the volume, the weight, and the condensing surface of the large cylinders.

The Woolf system—that is, the direct passage of steam without any intermediate reservoir—requires a high ratio between the volumes of the cylinders, especially where the distribution is made by the single valve, but it is probable that a ratio of 1:2.50 would be sufficient, and, moreover, an arrangement with a reservoir could be adopted to still further diminish the diameter. The working of the Woolf system gives, it is true, a little higher maximum power in consequence of the almost complete elimination of the fall of pressure between the cylinders, but an equivalent advantage can be obtained by the reheating of the steam, which is effected by passing through the smoke-box the tubes forming the intermediate reservoir between the cylinders of each pair working compound.

This supposes a different method of connection between the pistons on the same side, which is not an insoluble problem. There are several solutions, among which is an original one given by me in 1879. This was for a passenger engine having the cylinders placed between the forward and the middle pair of driving-wheels. Figs. 16 and 17* represent another plan made a little before for the lateration of a freight engine on the Northern Railroad of Spain. This change required only the lengthening of the frame and the addition of two small cylinders in front of the old ones, which were used as low-pressure cylinders. Fig. 18 shows, on a larger scale, the interior stuffing-box making the joint between the hollow rod *h* of the small piston and the solid rod *g* of the large piston, by the use of the tube *i* fixed in the partition separating the two cylinders.

The tandem arrangement applied to machines with six and eight wheels coupled has always the inconvenience of throwing too much weight on the front of the engine and, consequently, of requiring sometimes an additional load on the rear end—a doubtful solution—or the addition of a carrying axle in front which will not permit us to utilize all the weight for adhesion and will require an increase of the dead weight.

The Baldwin shops in Philadelphia have built for the Baltimore & Ohio Railroad a locomotive with four cylinders arranged in two groups working on the Woolf system, but the arrangement differs from the preceding one from the fact that the cylinders on each side, instead of being placed one before the other, are placed one above the other, as shown in figs. 30 and 31. The two piston rods are joined to a crosshead working in four guides, and with the pin for the connecting-rod in the center, as in the arrangement shown in figs. 19 and 20.* The cylindrical valve, as shown in fig. 31, is worked directly by the link without the use of the rock-shaft common to American engines.

The locomotive in question has two coupled axles and a truck under the cylinders. The builders proposed to make an arrangement of double cylinders which could be applied easily and at small expense to the ordinary American engine.

The principal dimensions of this engine are as follows: High-pressure cylinders, 12 × 24 in.; low-pressure cylinders, 20 × 24 in.; ratio of volumes, 1:2.78; diameter of driving-wheels, 66 in.; grate surface, 24.11 sq. ft.; total heating surface, 1,604 sq. ft.; working pressure on boiler, 160 lbs.; weight on driving wheels, 75,400 lbs.; total weight, 105,300 lbs.

The following arrangements were adopted for the single valve corresponding to the two cylinders of each pair: Outside lap for the small cylinder, $\frac{3}{4}$ in.; for the large cylinder, $\frac{5}{8}$ in. Inside lap for the small cylinder, $\frac{1}{8}$ in.; for the large cylinder, $\frac{1}{4}$ in.

It was proposed in this engine to have the passages between the two cylinders as simple and direct as possible. This was reached, but with a very complicated casting; in fact, the two cylinders, the steam-chest, and one-half of the saddle were made in a single casting.* The arrangement adopted seems, besides, open to a serious objection for a very heavy engine.

Fig 31.

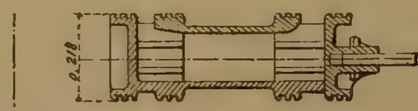
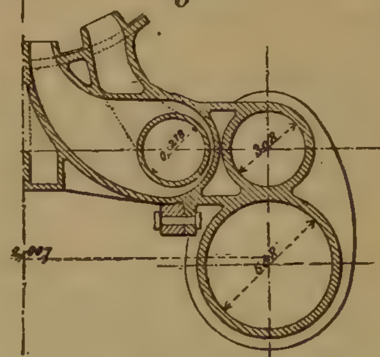


Fig 30.



The Woolf system permits us to obtain a maximum work a little higher than that of the reservoir system, but on the condition of accepting a certain difference between the work done by the two pistons. According to indicator diagrams taken of this engine the ratio of the work in starting is 1 for the small cylinder to 1.385 for the large one; but with the system of starting employed, which annuls the action of the small piston, the whole work can be, in starting, exerted by the large piston. This difference has no bad effect in the tandem arrangement, and it does not amount to much in the two-cylinder engine; it cannot be neglected when the pistons act on the extremities of a crosshead the center of which acts upon the connecting-rod. From this point of view this arrangement seems inferior to the tandem form, and would require more modifications in applying it to existing engines. The lowest point of the large cylinder is 22 in. below the common axis, and unless the cylinders are inclined, which is contrary to American custom, the wheels could hardly have a diameter less than 56 in., which is greater than is generally used for a consolidation engine where the wheels are usually 48 or 50 in. in diameter.

The Baldwin engine is the first example in practice of a four-cylinder locomotive with cylinders placed in pairs, one above another, although this arrangement had been previously proposed.

(TO BE CONTINUED.)

## GAS FURNACES.

At the recent meeting of the Institution of Mechanical Engineers in London, Mr. Bernard Dawson read a paper on this subject, a summary of which is given by *Nature*.

* See March number of the JOURNAL, page 110.

* M. Mallet does not seem to be aware that casting the cylinder and half the saddle in a single piece is an arrangement very generally adopted in this country, and which has been found to work without serious objection. The addition to the casting made in the Baldwin compound engine is the cylindrical steam-chest, which in fact makes the casting consist of three cylinders instead of one; but this is not a serious objection for our founders.

He began by stating that the greater number of gas furnaces in which crude heating gas has been successfully applied have been of the reversing regenerative type. There are many processes, however, requiring temperatures below that maintained by the use of regenerators, and in these gas furnaces have also been used with success. It is also often an advantage to be able to concentrate in one spot the manipulation of all the fuel required in scattered furnaces. For these reasons, among others, it is often desirable to employ gas fuel when the cost of saving in fuel may be a secondary consideration. The annealing of steel castings, heating plates and angle bars, etc., are cases in point. On the other hand, there are cases in which a higher temperature is required, such as cannot be attained by combustion of gas with cold air, and in these continuous regeneration—as opposed to reversing regeneration—may be applied; the regeneration having the effect of recovering the heat from the waste gases. In either case, the escaping gases must retain sufficient heat to secure the necessary draft; in fact, regeneration may be carried too far. The Author gives a useful word of warning on this point, some designers being of opinion that they cannot have too much of the good thing, regeneration. There have been many failures due to a want of appreciation of this point.

The Author divides gas furnaces into four classes: (*a*) With reversing regeneration; (*b*) with continuous regeneration; (*c*) non-regenerative; and (*d*) with blow-pipe, or forced blast.

Furnaces with reversing regeneration (Class *a*) are of several different kinds. (1) The ordinary Siemens furnace, the arrangement of which is well known. (2) The Batho or Hilton furnace, in which the regenerators are above ground. (3) Furnaces in which the air only is regenerated, the gas being admitted direct. (4) Furnaces in which a portion of the waste heat is taken back to the producer, as in the new Siemens furnace. (5) The regenerative blast-furnace stoves of the Cooper and Whitwell types.

In furnaces with continuous regeneration (Class *b*) the air is heated in flues by radiation or conduction from the bottom of the furnace, and through thin walls which separate the air-flues from the flues that carry the spent gases to the chimney.

In non-regenerative furnaces (Class *c*) the air is admitted to the furnace at atmospheric temperature.

The blow-pipe, or forced blast furnaces (Class *d*), are of two kinds: Firstly, those in which air is supplied at atmospheric temperature by a fan; and secondly, those in which the air is heated by the spent gases, by being passed either through coils or stacks of pipes, or else through brick tubes or flues.

For reasons already stated, we cannot follow the Author into the details of the various types here broadly sketched. The classification is, however, valuable, and supplies a standard which doubtless will be followed by others when dealing with this subject of daily growing importance.

In conclusion, he quoted the words of the late A. L. Holley, as follows: "Regenerative furnaces will gradually but inevitably take the place of the ordinary heating, puddling and melting furnaces, thus preventing the application of unspent furnace heat to steam generation." It should be remembered that in those days the generation of steam was looked on, in the general metallurgical trades, as the proper and legitimate means of recovering heat from waste furnace gases. How ill the device served this end those who know the difficulties and dangers of furnace gas fired boilers will recognize.

The discussion on this paper was opened by Mr. Aspinall, the Superintendent of Mechanical Engineering to the Lancashire & Yorkshire Railway, who bore testimony to the successful working of gas furnaces in engineering practice at the company's works, at Horwich.

Mr. John Head, who is connected with Mr. Frederick Siemens, also spoke at some length, in the course of his speech dealing with the new Siemens furnace, and giving instances of its successful working.

Mr. Smith-Casson also gave interesting particulars of a furnace he had designed and erected. This furnace has overhead regenerators, a type which is now attracting a good deal of attention. It is interesting to note that Mr. Smith-Casson does not advocate overhead regeneration in all circumstances. It is a subject, he said, upon which he has still an open mind. As another speaker pointed out, there is this objection to an elevated regenerator, that the heated air naturally rises to the highest point, and therefore the circulation may not be as efficient as in cases where the regenerators are placed below the hearth.

Mr. A. Slater described a device in an ordinary boiler furnace in which iron retorts are placed at the back of the furnace bridge, and in these steam is dissociated and returns to the furnace for combustion of the gases. As Mr. Macfarlane Gray pointed out, this appears nearly akin to the perpetual motion theories; but a useful effect may be obtained by transferring heat from a place where it is not wanted to a place where it is. Mr. Slater said the application of this device gave a saving of 38 per cent. of fuel burnt, which only proves that Mr. Slater's boilers must have been of extremely bad proportions originally.

A good deal of the discussion turned on the burning of gaseous fuel in steam-boilers. Professor Alexander Kennedy said, as to the saving of burning gas with regenerative furnaces in metallurgical operations, there can be but little divergence of opinion; but in the case of generation of steam, quite a different set of conditions will arise. In steel-making, for instance, it is necessary that there should be intense local heat, and the gases must leave the furnace at an enormously high temperature. In boiler furnaces intense local heat is to be avoided, and the products of combustion pass to the chimney comparatively cool. Thus a steam-boiler may show an evaporative efficiency or fuel economy so high that little more heat is left in the spent gases than is necessary to supply chimney draft, and in such a case regenerators would be useless. In metallurgical operations the efficiency of the furnace would be something absurdly low without regenerators, perhaps not more than 5 per cent. These remarks he intended for those people who think that so much better results can be obtained by complicated gas-generating devices in steam-boilers than by burning coal simply and logically on a grate.

Mr. Dawson replied to his critics at considerable length, but without adding much to what had been already said in his paper.

## THE NORTH SEA-BALTIC SHIP CANAL.

(From *Mittheilungen aus dem Gebiete des Seewesens.*)

### I.—HISTORICAL.

WHILE the canals of the ancients served originally only to carry water for irrigation or city supply, it was at a very early period that their use for purposes of trade and for carrying vessels began.

Ptolemy and Pharaoh both worked to connect the Nile with the Red Sea. Under the Emperor Nero a survey was made and a plan prepared for cutting through the Isthmus of Corinth. Claudius Nero, a stepson of the Emperor Augustus, in the year 12 B.C., built the *Fossa Drusiana*, a canal which carried boats and which connected the Lower Rhine with the Zuyder Zee, near the present town of Doesborg.

In the eleventh century there were boat-bearing or commercial canals in Italy. The first canal of this kind in Germany was built in 1391–98, by Lübeck merchants between the Elbe and the Trave. This Delvenau-Strecknitz Canal was intended to connect the North Sea with the Baltic, and enable trading ships to avoid the stormy and dangerous passage around Cape Skagen. It was 35 miles long and 3 ft. deep.

In 1525 followed the building of the Alster Canal, which had also the object of connecting the Baltic with the North Sea. It extended from the Beste, a tributary of the Trave, to the Alster Lake, the outlet of which—the Alster, a river 32 miles long—discharged near Hamburg. Unfortunately this canal had only a short life, the warlike owners of the adjacent provinces having filled up the canal a few years after its completion.

King Christian VII. of Denmark built, in 1777–84, the Eider Canal, which now runs from Holtenau, on the Kiel Fjord, to the Eider, above Rendsburg, where that river makes a sharp bend to the westward. The length of this waterway, including also a short stretch of the Eider, from the mouth of the canal to the town of Rendsburg, is 28 miles. This canal, which was afterward transferred by the Kingdom of Denmark to the Duchy of Schleswig, is still, 100 years after its first construction, in regular use. Although it has five locks and can only pass boats of 8 ft. draft, which hardly corresponds with the demands of the present day, yet last year there were passed through it 4,500 vessels.

The dangerous navigation around Cape Skagen, the northern point of Denmark, and the existence of the so-called "Sound Dues," an onerous tax on navigation, called into existence numerous projects for a new waterway between the Baltic and the North Sea, but none of these plans were carried out, owing to economic or political difficulties.

In 1886, when the German Navy had reached a point where it could be considered an important factor in the power of the Empire, the Reichstag passed a measure to provide for the building of the North Sea-Baltic Canal. The plans originated with the Hamburg engineer Dahlström, and the estimated cost of the work was about $38,000,000. The location was approved and the details of the work decided on, its beginning being sanctioned by the German Emperor, in July, 1886.

In October of the same year the preliminary works were begun, and on June 3, 1887, the work of building the canal was formally begun by the Emperor in person.

The preliminary works were pushed forward, so that in July, 1888, the greater part of the earthwork was in progress, and in October of the same year the last had been begun.

II.—THE BUILDING OF THE CANAL.

Starting from Brunsbüttel, at the mouth of the Elbe, in the deep water beginning at the Oste-Riff, the canal passes through the low marshy region of the Elbe, which is in places below the future water-level of the canal, through the Kudener Lake and the Burger Moor, and then, near Grünenthal, passes through a ridge some 80 ft. in height, which is the divide between the water-sheds of the Elbe and the Eider, and enters the valley of the Eider.

Passing through the swamps of the district periodically overflowed by the Eider and the Meckel Lake, it approaches the Eider at Schülp, where a strong dike or levee will be built to protect it against the freshets in the river.

Passing by Westerrönfeld the canal goes south of Rendsburg, and enters near Andorf the Obereider-see, which it follows for about 3½ miles, and thence follows the general course of the old Eider Canal, but avoiding its sharp curves, and crosses the Flemhüder-see at its upper end.

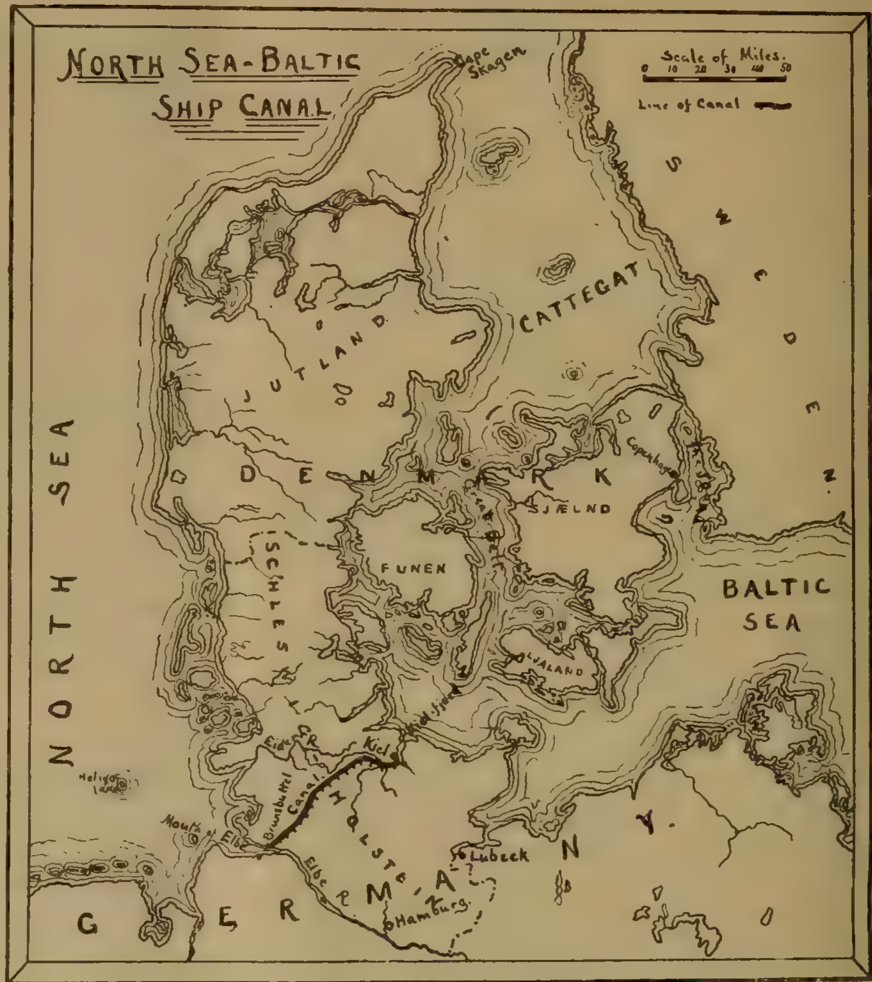
The eastern end of the canal is at the village of Holtenau, in the Kiel-Fjord. The accompanying sketch map shows the general course of the canal and its relative position and connections.

The length of the canal is 61.30 miles; of this 38.62 miles, or 63 per cent., is straight line. The curves are divided as follows:

| Radius of Curves. | Length in Miles. | Per cent. of Total Length. |
|---|---|---|
| 19,680 feet.......... ....... | [illegible].00 | 4.9 |
| 16,400 " ................ | 3.43 | 5.6 |
| 9,840 " .......... ..... | 8.[illegible] | 13.4 |
| 8,200 " ................ | 2.34 | 3.8 |
| 6,560 " .............. | [illegible].61 | 1.0 |
| 5,576 " .......... .... | 1.24 | 2.0 |
| 4,920 " ....... ........ | 1.86 | 3.0 |
| 3,280 " . . ............ | 1.98 | 3.3 |
| Total.................. | 22.68 | 37.0 |

The canal has only two locks, a tide-lock at each end to protect the water-level against the variations of the tide in the North Sea and the Baltic.

The Brunsbüttel lock will remain open during the ebb




and until the rising tide begins to flow into the canal; that is, from three to four hours on each tide. During this time ships can pass in and out freely.

The Holtenauer lock will remain open most of the time, as the rise and fall of the tide in Kiel Harbor is not great. It will only be necessary to close it when the variation between the harbor and the canal level exceeds 18 in. This happens only on spring tides, or in certain states of the wind, and observations extending over a series of years indicate that it will not have to be closed more than 25 days in the year.

On the rest of the canal there are no locks, so that ships will be able to pass through without delay. At Rendsburg a connection is made with the lower Eider by a lock through which vessels can pass, but this lock does not in any way affect the navigation of the canal itself.

On the straight sections and on curves of over 8,200 ft. (2,500 m.) radius, the width at bottom is 72 ft. On curves of less than 8,200 ft. radius, the width is increased in accordance with the following formula :

$$\text{Width} = 72' + \left(85' - \frac{\text{Radius}}{180}\right)$$

Thus on a curve of 5,400 ft. radius, the width of the canal at bottom would be $72' + 55' = 137$ ft. The depth everywhere at the average stage of water will be 29.5 ft.

The canal bed has a slope of 5 to 1, and the dikes, or protecting banks, of 2 to 1 ; in very soft ground the slope is 6 to 1. In the sections in high land the bank is protected by stone or rip-rapped for 6.5 ft. below low-water mark, and for 3.3 ft. above the average water-mark. In all the cuttings a berme 8.2 ft. wide is left, from the outer edge of which the slope, of 1½ to 1, begins. In low ground the berme bank is 16.4 ft. wide.

At the lowest stage of water the canal will have an available width of 118 ft. for ships drawing 19.7 ft. of water ; in addition to this, and to provide for battle-ships of great beam, six passing-places are provided, in which the width is increased to 197 ft. at the bottom. Besides these the Obereider-see and the Andorfer-see serve as passing-places ; the last-named lake can also be used as a turning place, giving room to turn around the largest ships.

The West Holstein Railroad will cross the canal on a high-level bridge, which will leave a clear opening of 138 ft. above the water. There will be three other railroad crossings where swing or drawbridges will be used, and three drawbridges for highway roads. For the less frequented roads 16 ferries will be provided, where passengers and teams will be carried across by ferry-boats.

The estimated amount of the earthwork required for the canal was about 100,000,000 cubic yards. The soil is chiefly sand with bowlders, or sandy loam, or swampy. The sand excavated is used for the dikes, and also for strengthening the bottom in swampy land. Packed down it sinks into the bog, giving the bottom and slopes greater resisting power. The bowlders taken out are valuable for rip-rapping, as stone is very scarce in the district through which the canal passes. While these bowlders are apt to hinder considerably the work of the steam-shovels, it must be remembered, on the other hand, that on the entire line there is no rock-work, and no blasting will be necessary anywhere.

In the first two months of work—October and November, 1886—there were 162,500 cub. yds. excavated. Since then the plant and working force have been so increased that in June and July, 1890, there were 6,956,300 cub. yds. moved.

The plant in use on the work at the present time includes 27 steam-shovels, 26 dredges, 15 steam-tugs, 72 barges, 97 locomotives, and 2,700 dump cars.

The workmen employed are chiefly North Germans, with a small proportion of Bohemians and Italians. They are lodged in barracks erected for the purpose, which have been designed and built with strict regard to sanitary conditions and to secure the greatest possible amount of comfort.

The locks and bridges will be begun during the present year, and the entire work is to be completed in the year 1895.

It was at first intended to fill up the Flemhüder-see entirely, but this has been abandoned on the petition of the neighboring landowners, who feared serious injury to their tree plantations. There will be now a part left open forming a sort of circular canal ; the upper part of the lake, to the line of the ship canal, will, however, be filled up.

### III.—COMMERCIAL VALUE OF THE CANAL.

The necessity for a canal before the time of railroads was so great that the old Eider Canal was built and used, in spite of its small depth of water, sharp curves, and numerous locks.

The railroads, however, altered this at a blow.

Canals are often closed on account of ice in winter, repairs, and sometimes lack of water. Their usefulness is limited by the nature of the ground and the supply of water, and the speed of ships passing through them must be limited on account of the washing of the banks.

The railroad can make much better time, and is better adapted to handle light freight. Moreover, branches can be run and stations placed conveniently for large manufactories and other points where freight originates.

A boat of 2,000 tons displacement carries about as much as a heavy freight train. For heavy freight and articles of low cost, the water transport, however, presents great advantages.

To sum up the considerations in favor of the North Sea-Baltic Canal, it will probably not remain closed by ice in the winter, nor is there chance of a short supply of water. Apart from its military use it is of the first importance commercially, carrying large sea-going ships and very much shortening the distance between the two seas.

The disasters to ships taking the route around Cape Skagen have been carefully recorded from 1858 to 1885. During this time there ran ashore on the west coast of Jutland, near Cape Skagen, in the Cattegat, in the Great Belt, in the Sound, on the Islands of Falstenbo and Bornholm 6,316 ships, of which 3,133 were total losses. The greatest proportion of disasters was in the months of November, 19 per cent.; the smallest in June and July, 4 per cent. From 1877 to 1881 a total of 91 German ships, with 708 persons on board, were lost, which would have been preserved had the canal been opened. The money loss for Germany in this period is estimated at $1,464,000.

The increasing safety for ships and cargo through the use of the North Sea-Baltic Canal is a great consideration, but it must be remembered that the entrance to the mouth of the Elbe and to the Brunsbüttel lock will not be easy in bad weather until some harbor works and lighting are completed. It should be noted also that the Danish and the Swedish Governments have done much in recent years to improve the lighting of the coast and the navigation around the Skagen.

The shortening of the voyage is a very important point for ports in the neighborhood of the eastern end of the canal. Ships for English ports starting from Lubeck will save 570 knots ; sailing from Wismar 530, and from Rostock 570 knots. The shortening of the voyage between Bornholm and the Thames will be 200 knots, and this saving will increase for ships bound for ports in the north of England.

Through the canal a new business route will be opened that ought to bring much business to the province of Schleswig-Holstein. Recognizing this fact, Prussia has undertaken the payment of $12,000,000 of the total amount of the cost of the canal, which was to be provided by the Empire.

As to the revenue to be expected from the canal, it is to be considered that the tariff charge for ships must be limited to an amount which will enable them to compete with the railroads for freight, and cannot, therefore, exceed a point which would enable the boats to carry at about three-fourths of the railroad rate. The sea route opened will, however, be of great advantage to some German industries. Coal and iron from the Rhine provinces, which heretofore have been able to compete with the English products only on the North Sea coast will, by the opening of this canal, in connection with the Dortmund Canal, be able to reach also the Baltic ports.

The building of the canal will make it necessary for the imperial authorities to improve the mouth of the Elbe and to put in additional lights there, in order to make navigation more secure for vessels seeking the entrance of the canal. It is intended to take measures for keeping navigation open and free during the winter season as well as for the rest of the year.

Official statistics show that in the five years 1877–82 in all 161,179 ships, having a registered tonnage of 53,000,000 tons, passed Cape Skagen, giving a yearly average of 32,235 ships and 10,600,000 registered tonnage. Of these, it is considered that ships from the north of England, Sweden, and Denmark will not use the canal, so that the proportion which would pass through would be about 18,000 ships of 5,600,000 tons. Adopting these figures, the estimated revenue from canal tolls will be about $1,000,000, while the expense for the canal service, repairs, etc., would be about $450,000, leaving a net revenue of $550,000. The Imperial Commission which made these calculations does not con-

sider that the estimate was at all sanguine, since no allowance was made for the fact that by the time the canal is opened in 1895, the steamship trade to the Baltic will probably have doubled, and the estimate given above of the number of ships and tonnage will be a low one.

An incidental advantage of the building of the canal will be the draining of some of the swampy lands along the line, which will be made available for cultivation; and there will also be a gain of fertile land by filling in the Flemhüder-see. It may also be expected that Danish and Swedish vessels will in some cases use the canal in stormy seasons and in bad weather when the northern passage would be especially dangerous.

IV.—MILITARY VALUE OF THE CANAL.

Through the peculiar situation of its coast-line fronting on two seas, divided by the peninsula of Denmark, which would probably be neutral in any war, the German Empire is obliged to protect two coasts with its fleet. Although the German Navy has been largely increased during recent years, it is still outnumbered by those of England, France, and Russia. This is the more unfortunate for the Empire, since it must keep strong fleets in both the North Sea and the Baltic, and is thus compelled to divide its naval strength. To unite these two fleets in time of war would require a great deal of manœuvring, partly through narrow channels, which could easily be closed by guns, torpedoes, and submarine mines.

The North Sea-Baltic Canal will change all this. Situated entirely within German territory, in 24 hours a number of large ships can be passed through it. One end of the canal is in the harbor of Kiel, already strongly fortified; the other is in the mouth of the Elbe, which can be easily protected, so that from a military point of view the canal may be considered safe.

The German General Staff at first opposed any expenditure for the canal. Later, however, its views altered, when an increase of the naval force was decided on, and it is mainly due to the influence of the General Staff that the building of the canal was decided on in 1886.

The advantage of the canal for the navy is seen when we consider that a naval power seeking to attack Germany in either sea can quickly be confronted by the entire fleet. In other words, the fleet can be moved on an inside line and its entire force thrown against an enemy advancing on either sea, thus practically doubling its force.

It is also to be considered that the ships now planned and under construction will almost double the present strength of the navy by the time the canal will be completed, in 1895, making Germany a strong naval power.

## THE PRESERVATION OF IRON AND STEEL STRUCTURAL WORK.

By Woodruff Jones, A.M.

One of the most important economic questions of the present day is the preservation of iron and steel structures. In this country many millions of dollars are annually spent in the erection and construction of these, and the amount is increasing in rapid proportion. Bridges, buildings, viaducts, ships, and machinery are now being made of these materials to almost the entire exclusion of others. From their very nature iron and steel are peculiarly subject to decay from atmospheric and other influences. The question of preserving them is not merely one of dollars and cents but, especially in the case of railroads, one affecting the lives and property of a large portion of the community. What, then, is the best method of preserving them?

The almost universal method is by means of paints, or the application of substances to their surface which will resist or retard the influence of air, water, and other destructive agencies. The requisites of a good paint for this purpose are that it shall adhere firmly to the surface and not chip or peel off, thereby leaving portions of the surface exposed. It must not corrode the iron, else the remedy may only aggravate the disease. It must form a surface hard enough to resist influences which would remove it by friction, yet elastic enough to conform to the expansion and contraction of the metal by heat and cold. It must be impervious to and unaffected, as far as possible, by moisture, atmospheric and other influences to which the structure may be exposed.

The paints that have been used for this purpose are principally asphalt and coal-tar paints, consisting of mineral and artificial asphalt or coal tar either applied alone or combined with each other and, more or less, with metallic bases, and iron oxide paints and lead oxide paints, especially red lead, in all of which the pigment is held to the surface of the iron or steel by combination with linseed oil.

The choice of paints must lie, so far as our present practical experience goes, between these three classes, zinc oxide being found to be entirely unsuitable on account of a propensity to peel off. What, then, is found to be the experience in actual practise with these?

Asphalt and coal-tar paints run when exposed to the sun and other sources of heat, which is a serious matter with vertical surfaces, and after a time become extremely brittle and scale off entirely, leaving the under surface exposed unless the paint is constantly renewed. In the mean time the exposed iron and steel are being corroded by rust.

Iron oxide paints, including "metallic brown," are paints made from iron ore, or by some chemical process with an iron base. These are invariably iron in a greater or less degree of oxidation, or, in other words, rusted iron. Now it is well known that one of the most active promoters of rust or decay in iron is the rust itself. Under the combined influences of the moisture and carbonic acid of the atmosphere iron oxide, or iron rust, becomes a carrier of oxygen from the air to the metal, rust begetting rust. It is therefore evident that this material alone has no preserving effect on iron; in fact, it promotes its decay.

How is it when combined with linseed oil in the form of paint? In the economy of nature iron oxide is a great disinfectant. When in contact with organic matter and moisture, even at a low temperature, under favorable conditions it readily gives up oxygen, destroying, more or less, the organic matter and being itself reduced to a lower oxide. When thus reduced, with equal readiness it absorbs oxygen from the atmosphere and again passes it on, thereby promoting and eventually insuring the destruction or transformation of the organic matter with which it may be in contact either in the soil or elsewhere. The same process appears to take place when combined with linseed oil in the form of paint and exposed to atmospheric influences, the oil being the organic matter.

If linseed oil, in drying, formed an air and water-proof film, it might be urged that the oxide of iron would be entirely protected from the direct influences of oxygen of the air and moisture; such, however, is not the case. The most eminent authorities have recently shown that the dried film of linseed oil, unless united with a pigment that combines chemically and forms a waterproof coating with it, actually absorbs water very much like a sponge. Where water will go, air will also go, and we thus have in direct contact with the iron oxide of the paint, which does not combine chemically with oil, those elements—air, moisture, and organic matter—which cause the iron to become a carrier of oxygen and a destroyer of what it is in contact with.

It is well known that iron paint darkens with age; this is caused largely by the iron oxide losing oxygen, which is partly transferred to the oil, burning it up and destroying its tenacity, as may be seen by examining iron structures painted for some time with iron paint or metallic brown, the paint being found extremely brittle and in feathery scales.

This is not all the damage that is done. The iron oxide in the paint becomes a carrier of oxygen to the very metal it was designed to protect, and the process of corrosion is commenced and carried on under the paint, which eventually peels or scales off, the surface of the metal being found more or less oxidized and corroded.

Asphalt and iron oxide being thus shown to be entirely incapable of preserving the iron, it remains for us to consider the effect of *red lead*. This pigment has the property of forming with linseed oil a *hard elastic coating* clinging with great tenacity to the metal. It has no oxi-

dizing effect on iron and does not act as a carrier of oxygen from the atmosphere after the paint has set, neither does it render the oil brittle nor promote rust.

When red lead fails it is principally by gradual wear or friction from the outside. It does not scale or blister, which both asphalt and iron oxide paints will do, thereby requiring a thorough scraping and removal of old material before a new coat can be applied. Any red lead pigment adhering to the metal forms a permanent base for subsequent paintings and is utilized in further preserving the metal.

The Government specifications for iron work in the new Library Building of Congress provide that "all the work not Bower-Barffed must be given one coat of pure red lead paint—*not metallic paint* of any kind, but *pure red lead*—before leaving the shop and before becoming rusted."

The experiments of the Navy Department on the preservation and fouling of plates covered with different pigments may be interesting. A plate of iron covered with asphalt paint was immersed in sea water for eight months and six days at the United States Navy Yard, Portsmouth, N. H. At the end of that period it was found to be covered with scum and mud and very badly rusted. A plate coated with iron paint immersed at Key West, Fla., was found to be covered with branch shell and coral, but little paint remaining, and very badly pitted and rusted. A plate with two coats of red lead, at the Norfolk Navy Yard, was found to have a few barnacles attached, but to be in fair condition, with no rust whatever on the iron after the paint was removed. It will be seen that not only did the red lead protect the iron better than the other pigments referred to, but that the plates were in far better condition as regards barnacles and fouling. The superiority of red lead being thus established, it is adopted for use on hulls of Government war-ships.

On the Dutch State Railroads a series of experiments extending over a period of three years were made with the above pigments on scrubbed plates, as well as those which had been pickled in acid to remove the scale. It was found that the red lead was superior in each case to the others.

If red lead is thus proven to be the best pigment for preserving iron and steel structures, what is the proper method of applying it? We have seen above that the value of red lead depends upon its forming a hard, elastic coating having a great tenacity for the iron. This is owing to its forming certain combinations with the oil and actually setting very much the same as plaster of Paris or cement sets when mixed with water.

To successfully work with the latter substances it is necessary to put them in shape as quickly as possible after mixing with water before the setting takes place. If the chemical action of setting has partly taken place the material may be moulded, but it is well known that good results will not be obtained. Red lead, like these substances, must be applied to the work before it sets with the oil. It is on this point that failures in the use of the pigment have generally occurred, because if it be applied after the combining or setting process has taken place, the hard, elastic, clinging coating will not be formed on the iron surface.

The following is the practise of one of our largest shipbuilding establishments in applying red lead to the hulls of Government vessels: The plates are first pickled in a dilute solution of muriatic acid, then passed through rapidly revolving wire brushes, which remove all scale and dirt, leaving the iron with a bright, smooth surface; then thoroughly washed with pure water and rubbed entirely dry and immediately coated with red lead and pure raw linseed oil. The red lead is first thoroughly mixed with just enough linseed oil to form a very thick, tough paste, which will keep for several days without hardening. This paste as wanted for use is thinned down to the proper consistency for spreading with pure linseed oil, and applied at once, care being taken to leave paint-pots empty at night. A gallon of paint thus prepared contains about 5 lbs. of oil and 18 lbs. of red lead, and will cover on first coat about 500 sq. ft., the second coat about 600 sq. ft.

In this way the red lead and oil get their initial set on the *surface of the iron*, and the closer the pigment is brought to the iron the more durable will it be found. Some parties prime iron with iron oxide paint or metallic brown before applying red lead, which I believe to be a mistake, as this paint readily scales from iron and, of course, carries the lead with it. Others coat the iron with oil before applying the red lead; this, too, prevents the adhering paint from coming in contact directly with the surface, and should be avoided, provided the iron is properly prepared, by thorough cleaning and removal of any scale and moisture, which is a matter of the greatest importance. In priming wood surfaces which are absorbent of oil, the best practise favors the putting on of a coat of pure oil, or oil thinned with turpentine, which shall penetrate the surface and form a binder for the subsequent coats. With iron the case is quite different, provided we have a paint which, from its very nature, can attach itself firmly to the surface, because it is out of the question for it to hold on to the surface of iron by any process of absorption into the pores of the metal, as linseed oil will not penetrate to any extent. Such a paint should be put directly on the surface of the clean, dry metal—as is done in the cases of Government vessels referred to—without the intervention of a coat of oil or other substances.

The rusting of iron before the application of paint, which is sometimes recommended, should by all means be avoided, as it not only prevents the contact of the paint with the metal, but induces a chemical action which may go on with its corroding work under the applied paint.

As to the relative cost of iron oxide paints and red lead, there is no doubt that the first cost of painting structures with iron oxide is somewhat less than with red lead. The best railroad authorities state, however, that labor in painting structural work costs twice as much as material. The true economy must, therefore, be sought in the durability of the paint as well as the preservation of the structure from rust. Actual experiments have shown that structures painted with iron paint had to be repainted the third or fourth year, those with red lead not until the sixth year. In the second painting with iron paint the old material must be entirely removed before a fresh coat can be properly applied, entailing considerable increased cost, whereas with the red lead no such expense is necessary, but, as before stated, a portion of the pigment remains on the iron, continuing to protect the surface, and is the very best base for the new coat, besides contributing materially toward it, thereby lessening the expense of each repainting.

It will therefore be easily seen that, although in first cost of red lead may be slightly dearer than the iron paint, yet in the long run it will be greatly cheaper, besides giving assurance, for the reasons above stated, that the structure is not deteriorating from the effects of the atmosphere and paint.

Before closing this article it might be well to allude to the effect of lamp-black when mixed in small quantities, say an ounce to the pound of red lead. It changes the color to a deep chocolate, a possible advantage in some cases, and also prevents the red lead from taking its initial set with linseed oil as quickly as when mixed with oil alone. Experiments recently made showed that this compound would remain mixed in paste form with linseed oil some 30 days without hardening. Thorough mixture is of the greatest importance and should be done in the dry state before adding the oil. If rapid drying is desired, Japan dryer can be mixed with the oil used in thinning the paste before application with the brush.

Too much stress cannot be laid on the great importance of having the metallic surface perfectly clean and as free as possible from scale and rust before the application of the paint. Where pickling with acid is impracticable, as is frequently the case in railroad and other structural work, thorough brushing with wire brushes should be resorted to.

## MECHANICAL TREATMENT OF MOULDING SAND.

In a paper recently read before the English Institute of Mechanical Engineers, Mr. Walter Bagshaw remarked that if a waster casting be made it is invariably and not unnaturally attributed to accident, when it may be more probably due to want of skill; for even moulders them-

selves are not generally credited with a scientific knowledge of the principles on which their art depends. In large shops there is, of course, a competent foreman, who is responsible for the execution of orders in the most economical way; whereas in smaller foundries, even important work, such as the preparation of cores and the mixture of sand, is not infrequently carried out by unskilled workmen in a rather empiric manner. On the subject there seems to be as much difference of opinion as there is diversity in practice. Some moulders place faith only in kneading or treading the few simple materials composing their facing sand, jealously guarding the preparation as a trade secret, and condemning all machine work; while others are equally emphatic in favor of the particular machine for grinding, riddling or combing, to which they have been accustomed.

He described a view, magnified 500 diameters, of sand found and much used in the West Riding of Yorkshire. He said, "In its natural state it will be noticed that a portion of the grains adhere together in clusters, varying in size from masses containing hundreds of sand grains to smaller groups of three or four grains, most of them small enough to pass through an ordinary fine riddle without disintegration. The form and size of the groups are very irregular, and many are covered with a fine scaly powder. Samples from the bulk show a preponderance of grain groups devoid of uniformity. There are exactly the same appearances in fine Mansfield and other sands, though the presence of sharp crystals may be more frequent, and the abraded corners not so conspicuous." Referring to another view he said, "This represents new sand mixed with coal dust and burnt sand. The black spots dotted over the new grains are particles of coal which attach themselves in this manner, and when subjected to the heat of molten metal are converted into coke, often enveloping the sand grain with a crust. In none of the specimens examined was coal found in a separate loose state. Other views illustrated samples of old sand very much like gas coke, with perhaps more of a metallic luster, and the extent to which sand may be destroyed by burning or chemical action." Numbers of these friable hollow husks occur in a more or less broken condition, and are easily reduced to fine powder by concussion with other particles. If used again in sufficient quantity, they will cake and cause metal to boil. One diagram illustrated the formation of a shell round a sand grain, a shell which could be cracked like a nut, exposing a kernel of clean sand. Coal dust, as commonly found, takes the form of angular splinters with laminated surfaces. When magnified 500 diameters it appears only like a fine powder; the larger pieces are not present in quantities if the coal has been properly ground. These materials, after incorporation, are generally coated with some other substance, plumbago being the most preferred; but it is difficult to give a correct impression of this article in a drawing. When viewed in bulk it is fluffy, like soot; and the outlines of separate flakes are not well defined by the prevailing light and shade. The chemical composition of sand will obviously affect the nature of the casting, no matter what treatment it undergoes. Stated generally, good sand is composed of 94 parts silica, 5 parts alumina, and traces of magnesia and oxide of iron. Sand containing much of the metallic oxides, especially lime, is to be avoided. Geographical position is the chief factor governing the selection of sand; and whether weak or strong, its deficiencies are made up for by the skill of the moulder. For this reason the same sand is often used for both heavy and light castings, the proportion of coal varying according to the nature of the casting. A common mixture of facing sand consists of 6 parts by weight of old sand, 4 of new sand, and 1 of coal dust. Floor sand requires only half the above proportions of new sand and coal dust to renew it. German founders adopt one part by measure of new sand to two of old sand, to which is added coal dust in the proportion of one-tenth of the bulk for large castings, and one-twentieth for small castings. A few founders mix street sweepings with the coal, in order to get porosity when the metal in the mould is likely to be a long time before setting. Plumbago is effective in preventing destruction of the sand; but owing to its refractory nature it must not be dusted on in such quantities as to close the pores and prevent free exit of the gases. Powdered French chalk, soapstone, and other substances are sometimes used for facing the mould; but next to plumbago, oak charcoal takes the best place, notwithstanding its liability to float occasionally and give a rough casting. The author then described mixing by hand riddling and treading, power riddling, roller mill, centrifugal mixer, toughness of sand, working expenses, and the durability of centrifugal mixer.

## THE UNITED STATES NAVY.

### THE PRACTISE SHIP.

THIS ship is under construction by S. L. Moore & Sons, at Elizabeth, N. J. The accompanying illustration, from the report of the Bureau of Construction and Repair, shows a side view and deck plan.

Peculiar difficulties attended the designing of this ship, which is intended to have, as far as possible, all the main features of a modern war-ship on a very limited displacement, and to be supplied with all the varied appliances necessary to give the naval cadets full training in the management of the latest type of vessels.

The vessel is a twin-screw steel cruiser, with the chief dimensions as follows: Length between perpendiculars, 180 ft.; extreme breadth, 32 ft.; mean draft, 11 ft. 6 in.; displacement, 835 tons.

Unlike some of the other cruisers, she is provided with considerable sail power. The rig is that of barkentine, the sail area being about 5,000 sq. ft.

The armament consists of four 4-in. rapid-fire rifles protected by steel shields; two 6-pounder, two 3-pounder, and one 1-pounder rapid-fire cannon; one 37-mm. revolving cannon, one Gatling gun, and two torpedo-tubes, one above water, and one bow launching tube.

There will be a full electric plant, steam steering gear and other appliances. Quarters are provided for captain, eight officers and 120 cadets and seamen.

The engines, one for each screw, are of the direct-acting, vertical, inverted, triple-expansion type, with cylinders 13½ in., 21 in., and 31 in. in diameter and 20 in. stroke. There are two boilers, each 8 ft. 8 in. in diameter and 17 ft. long, with two corrugated furnaces 39 in. in diameter.

The coal capacity is 140 tons on normal draft. With this supply the radius of action is 1,560 knots at 13 knots an hour; 2,400 knots at 10 knots an hour, or 3,850 knots at 8 knots an hour.

### THE NEW BATTLE-SHIPS.

A sketch of one of the new battle-ships has already been given in these columns, but the accompanying engraving, from the report of the Bureau of Construction and Repair, shows the design more completely, giving an elevation and two half-deck plans. The condensed description below gives the dimensions as finally settled. Two of these ships, the *Massachusetts* and the *Indiana*, are under construction at the Cramp yards, in Philadelphia; the third—the *Oregon*—at the Union Iron Works, in San Francisco.

The general dimensions are as follows: Length on water-line, 348 ft.; extreme breadth, 69 ft. 3 in.; draft, 24 ft.; displacement, 10,200 tons.

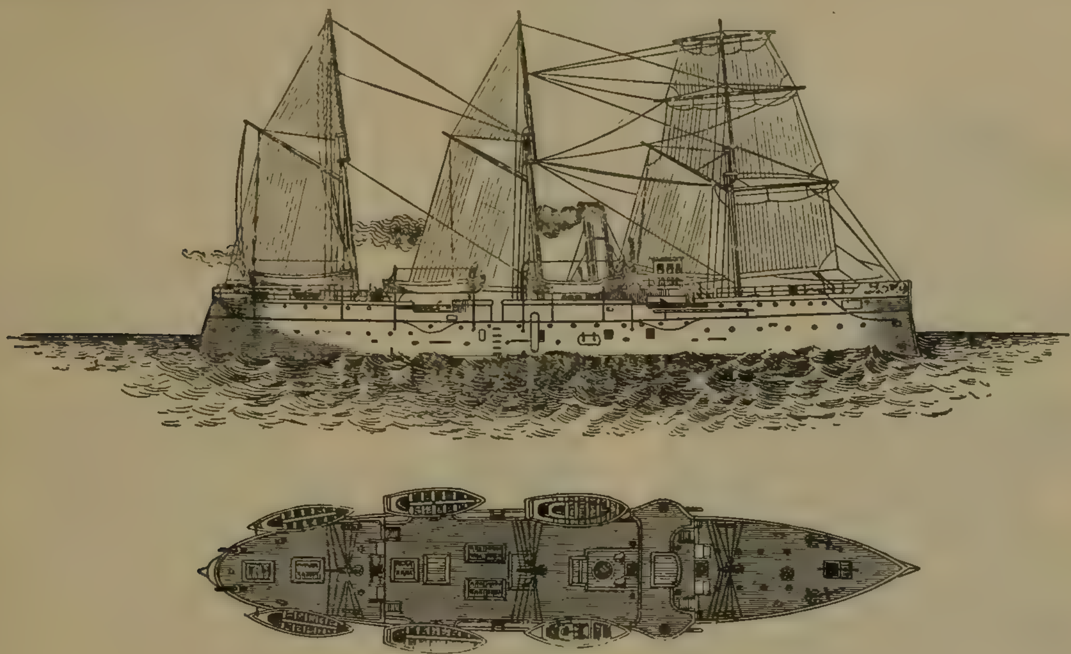
There is a belt of 18-in. armor extending 3 ft. above and 4 ft. 6 in. below the water-line. Rising from this at each end are armored redoubts of 17 in. in thickness, extending above the main deck 3 ft. 6 in., giving an armored freeboard of 15 ft. 2 in. These redoubts protect the turning gear of the turrets and all the operations of loading. The turrets are inclined, 17 in. thick, powerfully strengthened. The side-armor belt is backed by 6 in. of wood, two ¾-in. plates, and a 10-ft. belt of coal. The vessel above the belt has 5 in. of armor protection.

The 8-in. guns have barbettes of 10 in., inclined turrets of 8½ in., and cone bases and loading-tubes of 3 in. The 6-in. guns are protected by 5 in. of armor, and have 2-in. splinter bulkheads worked around the deck. The 6-pounders between decks have 2-in. armor worked around them; elsewhere the usual service shields. The 1-pounders are protected by 2 in. of steel. The deck over the belt is 2¾

in., and at the ends 3 in.; this is made up of two thicknesses of ½-in. mild steel plates with the remaining thickness in one plate. There is a 10-in. conning-tower, the connections being through a tube protected by 7 in. of steel.

the 13-in. guns, having a train of 14° across the middle line. Special attention has been paid to ease and protection of the ammunition supply.

A full electric plant, with search-lights, is provided for;

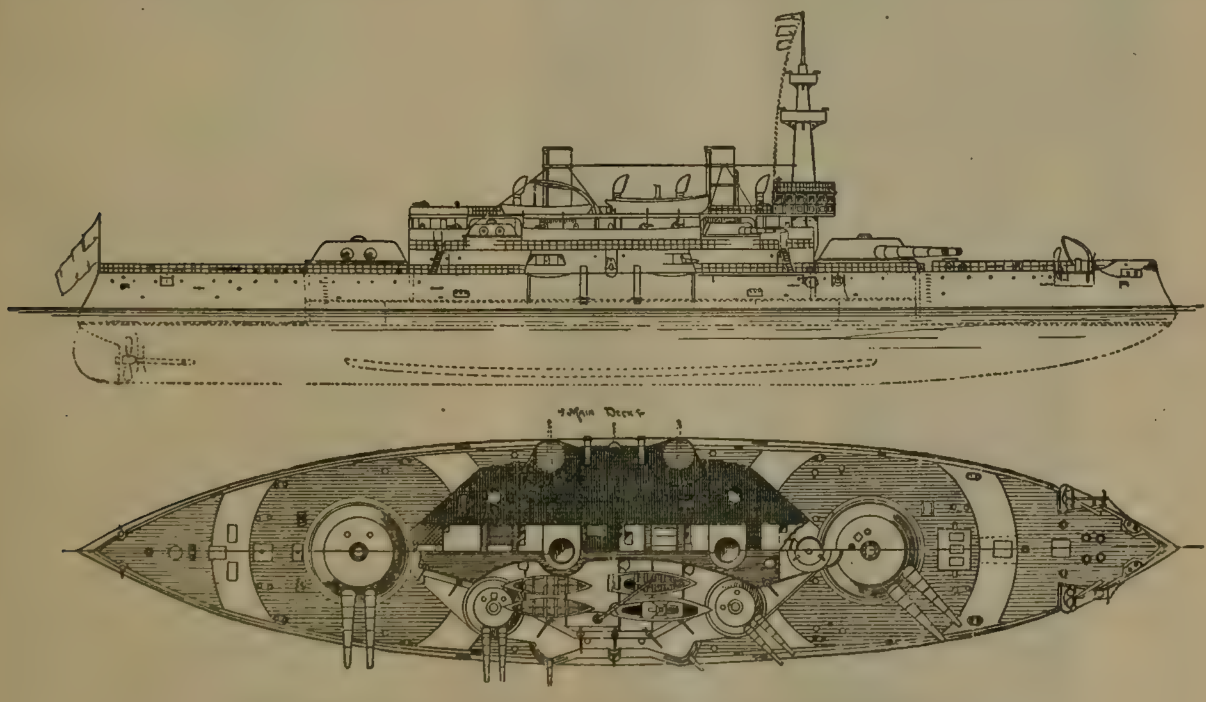


PRACTISE CRUISER FOR THE UNITED STATES NAVY.

The main battery includes four 13-in., 35 caliber, breech-loading rifles; eight 8-in. breech-loading rifles, and four 6-in. breech-loading rifles. The secondary battery consists of twenty 6-pounder and six 1-pounder rapid-fire guns, two Gatling guns, and six torpedo tubes.

also torpedo-nets and all the latest appliances. Special strengthening has been given to the sides and deck, to enable them to withstand the great strains caused by the firing of the larger guns.

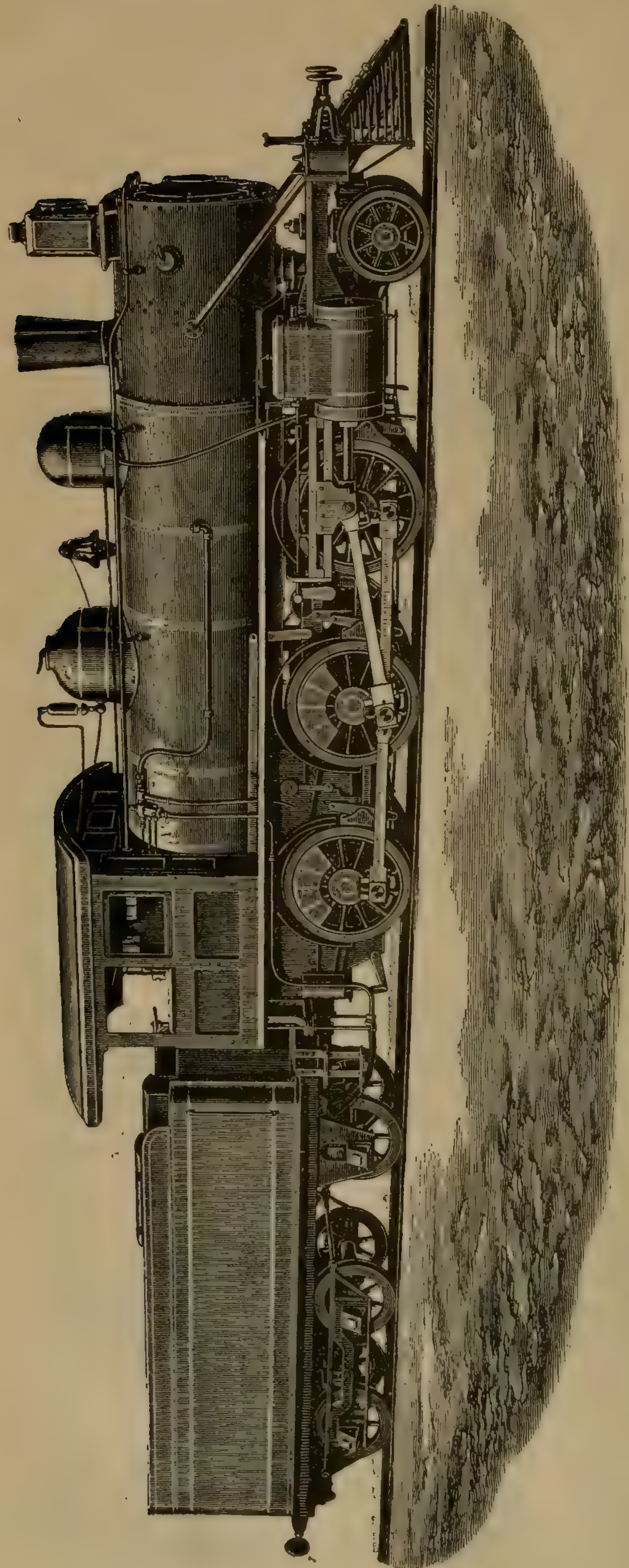
The ship has twin-screws, each driven by a direct-acting,



THE NEW BATTLE SHIPS FOR THE UNITED STATES NAVY.

The 13-in. guns are 17 ft. 8 in. above water and have great arcs of fire; the 6-in. guns are 14 ft. 10 in. above water, and all fire across the center-line. The 8-in. guns are 24 ft. 9 in. above water, and can fire over the tops of

vertical, inverted, triple-expansion engine, with cylinders 34½ in., 48 in., and 75 in. in diameter and 42 in. stroke. They are expected to give the ship a maximum speed of 16¾ knots, and a sustained sea speed of 15 knots. Steam



MOGUL LOCOMOTIVE FOR JAPANESE GOVERNMENT RAILROADS.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

is furnished by two single-ended boilers, each 10 ft. 2 in. in diameter and 8 ft. 6 in. long; and by four double-ended boilers, each 15 ft. in diameter and 18 ft. long. The working pressure will be 160 lbs. There are auxiliary engines for pumping, draining, ventilation, and running the dynamos.

The ship carries no sails, and has only one military mast carrying two tops for rapid-fire and machine guns. The ammunition for these can be carried up inside the masts.

TRIAL OF THE "BENNINGTON."

The official trial of the *Bennington* was made February 28, by a trip from New London, Conn., on the Atlantic and down Long Island Sound. On a four hours' run, with high wind and heavy sea, making about 65 knots, the average speed was about 16.5 knots, the highest 17.2 knots an hour. The highest pressure on the boilers was 170 lbs., the greatest speed of the engines 159 revolutions per minute. Under the conditions of the trial the engines developed about 3,314 H.P., or 86 H.P. below the contract requirements. The ship, it is stated, acted very well, and was easily managed, even in a pretty heavy sea.

The *Bennington* is a duplicate of the *Concord*, which was described and illustrated in the JOURNAL for April, 1890, page 168. She is an unarmored gunboat 226 ft. long, 36 ft. beam, 14 ft. mean draft, and 1,703 tons displacement. She will carry six 5-in. rifled guns, five small rapid-fire guns and eight torpedo-tubes. The twin-screws are driven by two vertical triple-expansion engines, each having cylinders 22 in., 31 in., and 50 in. in diameter, and 30 in. stroke. The ship will have a full electric light plant and other modern appliances.

THE NEW PROVING-GROUND.

The new naval proving-ground, which is to take the place of the present one at Annapolis, is at Indian Head, Md., on the eastern bank of the Potomac, 26 miles below Washington. It is much better adapted to the purpose than the old ground, where there was never room enough.

The new grounds have been fitted up under the charge of Ensign R. B. Dashiell, U. S. N., who was detailed for the work. The tract occupied by the grounds includes 659 acres of land, so as to give a considerable reservation on all sides of the firing ground, in order that in case of an accident flying pieces of metal will not be likely to fall on private property, resulting in claims for damages.

From the landing a valley several hundred feet wide extends inland, while on either side the high hills form natural butts on which the heaviest projectiles will make no impression. A ravine branching off some distance up the valley forms a sheltered location for the powder magazine and storehouses. When work was commenced the valley was a marsh, but the stream flowing through it has now been confined to a single channel and a system of drain-

age has been established by which all surface water is carried off.

There will be three firing positions or batteries. The first and most important of these is the velocity battery, which is now nearly completed. It is placed several hundred feet up the valley from the landing on the right-hand side, and will for the present contain mounts for 6-in., 8-in. and 10-in. guns. The projectiles will be fired directly across the valley into a sand butt made by excavating a tunnel into the side of the hill and filling it with sand. This is 500 ft. from the battery, and between the two are two velocity screens 100 ft. apart connected by electric wires with the chronograph house, situated over the hill behind the gun platforms and several hundred yards away, where the jar caused by firing the heavy guns will not affect the delicate instruments by which the time of the projectile's flight between the two screens is measured. An excellent bomb-proof, capable of affording protection to a large number of men, has been found by tunneling into the hill-side near the gun platforms. It will also be a convenient place for storing heavy projectiles near the guns.

The range battery is to be placed on the opposite side of the valley near the river, in a position where it will command a clear range directly down the river, and long enough to range any gun that will be built for the navy. Work on this battery is advancing rapidly. A third battery will be placed near the wharf, almost at the water's edge, in a recess cut into the hill-side. This will be used for testing experimental guns where there is danger of bursting, and the high banks will prevent flying fragments from doing any damage.

The most interesting feature of the proving-ground is the system of handling and moving heavy guns or other material. A specially designed scow has been built, carrying an ordinary standard gauge railway track and a special car on its top. This car can be run off on the railway at the Washington Navy-Yard and can be loaded in any of the shops. In the same manner it can be run off the barge at Indian Head upon a track running back quite a distance from shore.

A traversing car, carrying a traveling crane, is then run over the car, and the weight to be moved is lifted by the crane. The traversing car is then run upon a turntable, by means of which it can be shifted to any track desired and carried to any part of the ground where it is wanted. The gun platforms are elevated so as to be exactly level with the top of the traversing car, so that the crane can be run off of the car and directly over the carriage on which the gun is to be placed. The crane is capable of lifting 75 tons. It has just been completed at the Washington ordnance shops. The hoisting gear is carried overhead, supported by a strong framework of steel, resting on the track wheels. The gear has a transverse motion, as well as vertical, so that the load can be deposited at any point within the 13 ft. covered by the crane.

## A JAPANESE MOGUL LOCOMOTIVE.

THE accompanying illustration shows a locomotive built by the Baldwin Locomotive Works, in Philadelphia, for the Japanese Government Railroads. The engine is of 3 ft. 6 in. gauge, and is one of several in use on a road having very heavy grades and sharp curves. One of these engines was recently tested specially on the section of 15 miles between Gotembu and Numadzu, where there is a total rise of 1,500 ft.—an average of 100 ft. to the mile, the grades varying from 88 ft. to 132 ft. to the mile. The performance is stated to have been very satisfactory, though no particulars are given.

The engine, as will be seen from the engraving, is of the mogul type, with six drivers and a two wheel truck, outside cylinders and extended smoke-box. The boiler is of steel, the barrel being 57 in. in diameter. The fire-box is of steel, 7 ft. 5¼ in. long, 2 ft. 5¼ in. wide, 4 ft. 8 in. deep in front, and 3 ft. 11 in. at back. There are 201 tubes, 10 ft. 9 in. long and 2 in. in diameter. The heating-surface is: Fire-box, 109 sq. ft.; tubes, 1,122 sq. ft.; total, 1,231 sq. ft. The usual working-pressure is 140 lbs.

The cylinders are 18 in. in diameter and 22 in stroke. The steam-ports are 16 × 1½ in., and the exhaust-ports 16 × 2½ in. The valve motion is of the usual shifting link type.

The driving-wheels are 48 in. in diameter. The fixed wheel-base of the engine is 12 ft., and the total wheel-base 19 ft. 8 in. The driving-wheels are spaced 6 ft. apart, and the distance from the center of forward drivers to center of truck is 7 ft. 8 in. The center of the boiler is 6 ft. 6 in. above the level of the rails. The engine is fitted with driver-brakes. Its total weight is 40 tons.

The tender is carried on one pair of 33-in. wheels in fixed bearings forward, and a four-wheeled truck under the rear end. The tank has a capacity of 2,600 gallons.

## THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

BY FIRST LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.



(*Continued from page* 126.)

### IX.—TESTING.

THE efficiency of a system of mines depends upon a thorough testing of all the material and means employed in its construction and operation. This testing begins in the workshop and is continued unremittingly so long as the mines are in service. The never-ceasing motion of the sea, storms, wear and tear of material, loosening of joints, and the varying pressure upon the case, are some of the causes in constant operation to impair the efficiency of a submarine mine.

Before the mines are planted all the material to be used is subjected to careful mechanical or electrical tests, or both. The mine-cases, for strength and water-tightness by submergence and hydraulic pressure; the cables, for tensile strength and the insulation and conductivity of their wires; the fuses and disconnectors, for resistance and efficiency; the anchor-ropes, for tensile strength; the anchors, for holding power, and the junction-boxes and all mechanical joints, for water-tightness. While the mines are being put down, all joints and connections between electric wires are tested as they are made. The batteries are tested for electro-motive force and general efficiency. After the mines are down and the final connections made, the electrical tests are the only ones then available, yet with proper instruments, it is possible at any time to determine the condition of the whole system or of any particular mine.

The above refers particularly to a system of electrically controlled mines. With a system of purely self-acting mines all the mechanical tests would be applied to the material. To thoroughly test the efficiency of a mine of this character, whether explosion is produced by direct contact or by a falling weight, it would be necessary to fit it up in all respects as for service, except the exploding charge, to properly moor it, and then subject it to all sorts of collisions with a vessel at different rates of speed. A subsequent examination would determine whether or not it had behaved in a satisfactory manner.

All the cables of a system of electrical mines are led through an underground gallery to the testing-room at some secure point on shore. In a permanent work this would usually be in an underground casemate. Here are gathered all the instruments for testing and sometimes the batteries for firing the mines. The wire from each mine is led to a separate binding screw on the test-table and given a number corresponding with its mine. A separate galvanometer for each mine is desirable. The testing battery should be in addition to the one used for firing.

The cables are usually submerged in tanks before they are put down, and tested for resistance and conductivity. The fuses are tested for efficiency by connecting them up in a circuit, which includes a resistance coil representing

the entire resistance of the circuit as arranged for actual service, and exploding them. This test will also indicate the safe limit of strength of current for use in ordinary testing. To test the efficiency of the disconnector or cut-off-fuse, a circuit is made up which includes a mine and disconnector-fuse arranged as in service, and a resistance representing the other parts of the mine circuit, and then fired with a strength of current sufficient to fuse the platinum wire bridges, and then testing to see if the broken end of the wire is properly insulated.

The condition of a mine as regards moisture is a difficult thing to ascertain. Resort may be had to what is known as the *sea-cell* test which, although delicate, is about the only one possible. In this arrangement advantage is taken of the fact that if two suitable plates of metal, as zinc and copper, or zinc and carbon, are immersed in salt water, a current is generated capable of deflecting the needle of a galvanometer, which deflection varies in direction and in degree with the metals used. The simplest form of a "sea-cell" is to place in circuit within the mine-case, between the circuit-closer and the shore, a zinc plate, and beyond the fuse to form the ordinary earth-connection is a plate of carbon. At the shore station is a sensitive galvanometer from which connection is made with a submerged copper plate. By connecting up to the galvanometer, carbon and zinc plates, as well as copper, another set of combinations would be obtained, giving different indications on the instrument. Under normal conditions, when the mine is dry, a sea-cell is formed between the carbon plate and the copper of the home station, and a deflection is given to the needle of the galvanometer in a certain direction. Should, however, the mine-case leak and the zinc plate within come in contact with sea water, a cell is formed between the zinc and copper pair, and a different deflection is given to the needle. Should the cable become injured and its copper wire exposed to the sea, a cell of two copper plates will be formed and the fact indicated by the galvanometer.

To determine whether a buoyant contact mine maintains its position the telephonic test may be had. For this purpose there is a telephone at the shore station and one within the mine, properly connected. Upon the diaphragm of the latter a number of small loose shot are placed. The uniformity with which the mine sways under the action of tide or current will give a good indication as to the condition of its moorings. Should the shot come to a rest, it can safely be concluded that the mine has met with some mishap and is upon the bottom.

### X.—FIRING.

Almost any kind of an electrical current may be used for firing submarine mines. The objections to a high-tension current, such as is generated by a frictional or dynamo-electrical machine, have been mentioned in connection with fuses. An open-circuit battery generating a current of low-potential, like the Ladauché, is much to be preferred. Such a battery possesses the advantages of being easily cared for, economical, and always ready for use, and is now generally employed for both testing and firing purposes.

The manner of firing electro-contact mines has already been explained. The contact of a vessel with the mine is, by means of a circuit-closer, made to ring a bell or drop a shutter, leaving it to the judgment of the observer whether or not to switch in the firing-battery and fire the mine. To render the mine automatic, the signalling current, instead of giving the usual signal, is made to bring in the firing battery at once. This may be done in various ways, as, for instance, by making this current act upon an electro-magnet which, drawing down a pronged lever into two cups of mercury properly connected with the firing-battery, brings this battery automatically into circuit.

When the mines are connected up in groups, the explosion of one of the group may be made to break the circuit for that group for a few seconds, until the tumult caused by the explosion shall have subsided, reducing thereby the danger of sympathetic explosion.

To serve as a permanent indication to the operator at the firing-station that a mine has been exploded and is out of action, it is customary to introduce into each circuit at that station an *igniter*, a contrivance much like an ordinary fuse which, exploding with a mine, serves the purpose indicated.

At night, or as an extra precaution during fogs, guns bearing upon the mine-field may be loaded, trained, and so connected up with the firing-battery that the explosion of a mine will automatically draw their fire upon that part of the field.

*By observation.*—In an observation, or judgment mine, no indication of its proximity to the mine is given by the vessel itself. Its position must in some way be determined from the shore station. The first controllable mines were put down by the Confederates in the James and some of the Western rivers. The channels being narrow, a single mine was all that was required, and the only preparation necessary was a firing-pit on one bank, and a stake or some marked point on the other and in line with the mine. A vessel in the channel and upon this line was within the destructive area of the mine. When, however, the mines are numerous and distributed over a considerable area, two observing stations are necessary, and the position of the hostile ship must be determined by simultaneous observations taken from both with plane-tables, theodolites, or other angle-measurers. The position of the mines may be known by the bearings of stakes or distant objects, but the better way, and the one now usually employed, is by the use at each station of a permanent graduated arc upon which is indicated the bearing of each mine or group of mines. This arrangement gives to an enemy no indication of the position of the mines. The stations should be so situated that the lines passing from them over each mine shall form as nearly as possible a right angle.

The two stations having been selected overlooking the mine-field the mines are buoyed, and from both stations the bearing of each mine is carefully taken and recorded. This might be the compass-bearing, but the use of the permanent graduated arc is to be preferred. This firing arc, as used in the English service, is a cast-iron skeleton frame including 77° of a circle of 3½-ft. radius. Above this arc a telescope, with cross-wires, is mounted upon a vertical axis, which is the pivot of the circle. Below the telescope, and rigidly attached to this pivot, is an arm extending to the outer rim of the instrument, and carrying a contact-making point at its extremity. The arc having been properly set up and levelled, the bearing of each mine is carefully taken, and a contact-point numbered to correspond with its mine is securely clamped to the outer rim. In tracking a vessel, when the telescope swings upon the line of a mine, the arm striking against its contact-point indicates the fact to the observer, who can then put down the corresponding key upon the switch-board. By insulating these contact-points, and properly connecting them up with the firing-battery, the latter may be brought into circuit without the intervention of the operator, although this is not the usual method.

Judgment mines may be fired either by single or double observation, but the former can be employed only for a very limited number connected up to one line and fired simultaneously, marking buoys indicating to the observer the position of the mines. In double-observation firing there are two or more stations, depending upon the number of lines of mines, each station having an observer and an instrument. The station at which the batteries and testing instruments are located is known as the firing-station.

Fig. 21 shows a double line of electro-contact mines in groups of seven. *A* is the firing, *B* an observing station. The arrangement of the electrical wires is as follows: Starting at the fuse in the mine-case one terminal is put to ground through the anchoring gear, the other passes to the junction-box *a* through the disconnector-fuse to the multiple cable *b*, thence to station *B*. Here the wires are separated, pass over the key-board, and then, in one or two multiple cables, to station *A*, where the wires are again separated, passing over the key-board at the firing-station to the firing-battery and to ground.

As thus connected up there will be, under ordinary circumstances, two breaks in each electrical circuit—at the key-boards of the stations *A* and *B*—which must be closed before the mine can be fired. Suppose a vessel to be

approaching the mine-field, as upon the line *B* 1. The observer at *B*, the instant it passes upon that line, puts down his key, closing the break at his station and leaving only that at *A*. Should the vessel hold its course, the observer at *A*, when it arrives upon the line *A* 1, or over mine No.

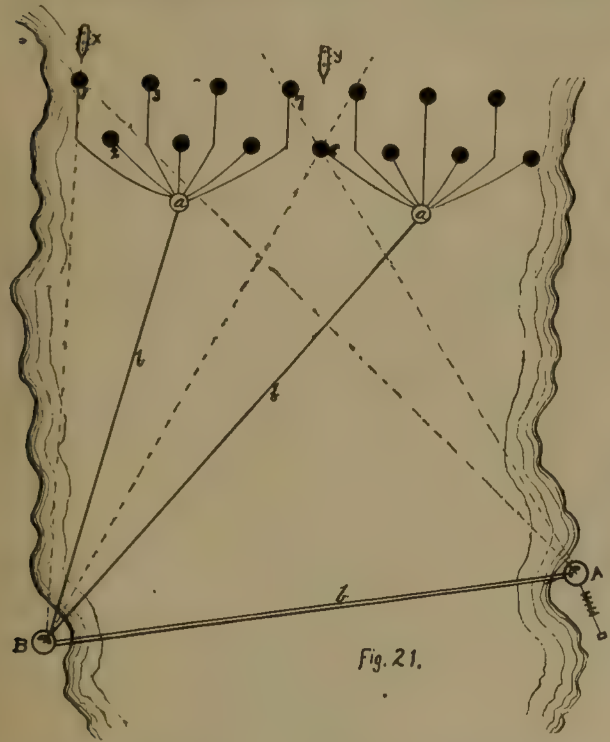


Fig. 21.

1, puts down his key, the circuit is closed and the mine fired. If approaching, as at *y*, both keys would go down simultaneously when the vessel arrived over mine No. 8.

With such an arrangement as above indicated, there would always be the possibility that the observers at the two stations might be following different vessels when more than one was approaching the mine-field, and so failure to explode the mines result. This difficulty can be obviated by an arrangement by which the observer at *B* can cause a signal corresponding to each individual mine to operate at the firing-station so long as a vessel remains upon its line, leaving the final act of firing the mines with the observer at that station. Electrical communication must, of course, be maintained between the two stations.

When the mines are upon a single line, as shown in fig. 22, the firing arrangements are very simple. At the firing-station *A* are the electrical batteries and a firing arc arranged, as in the case just described, with seven contact-points to indicate the line of mines. *B* is simply an observing-station. The observer here is provided with a telescope mounted in much the same way as has been described, but without the graduated arc. This is set to mark the line of mines. Upon the approach of a hostile vessel a warning signal is set in operation at the firing station, which is changed to the danger signal so long as it remains within the destructive reach of the mines. The observations taken at *A* determine when and what mines are to be fired.

The objection to a single-line arrangement of mines is that the destruction of a single mine opens a gate to the harbor; also, the discovery of the presence of one would indicate to an enemy the approximate position of the whole system, knowledge that would be of the greatest value were countermining operations to be undertaken. It might be said, however, that the necessity for depending upon a single line of mines is likely to be rare. In this connection it may be mentioned that a plan for running out a line of single mines in any desired direction has been proposed. This plan contemplates securing the mines to a large hawser, the end of which is carried out in the desired direction and rove through a heavily anchored block, and the hawser then drawn taut on the bottom. Whether this scheme is a practicable one may be questioned.

Both the firing and observing-stations must not only have a clear view of the mine-field, but must also be in situations rendered secure against attacks by landing parties from a hostile fleet, as well as from the fire of machine and rapid-fire guns. Security may usually be attained by placing the stations at some distance from the shore and concealing their location from the enemy, supplementing these precautions, when necessary, with means of protection and defense. That neither station should be in close proximity to a fort or battery is evident. The use of smokeless powder for heavy guns has, as yet, scarcely reached the experimental stage, and under present conditions the station observers of a mine system would be seriously handicapped by the smoke, noise, and confusion prevailing in the neighborhood of a battery in action.

*Skirmishing Mines.*—To confuse an enemy as to the position of the permament mines, as well as to give warning of the approach of small boats at night or in foggy weather, as for countermining, it is proposed to scatter irregularly in front of the ground occupied by the regular system numbers of small electro-contact mines. These would ordinarily be arranged to fire automatically, although not necessarily so.

XI.—COUNTERMINING.

To neutralize or destroy the mines of an enemy resort is had to countermining. Various means are resorted to to accomplish this object. In the case of electrically controlled mines, the most effective way of putting a group or system out of action is to rupture the multiple cable leading to the firing-station. Next to this the destruction or neutralization of the individual mines is to be sought. This is accomplished by cutting its electrical cable, or destroying the mine by attaching to it a small electrical mine and exploding it.

A fleet setting out to open a passage in the mine-field defending a harbor would provide boats for creeping, for

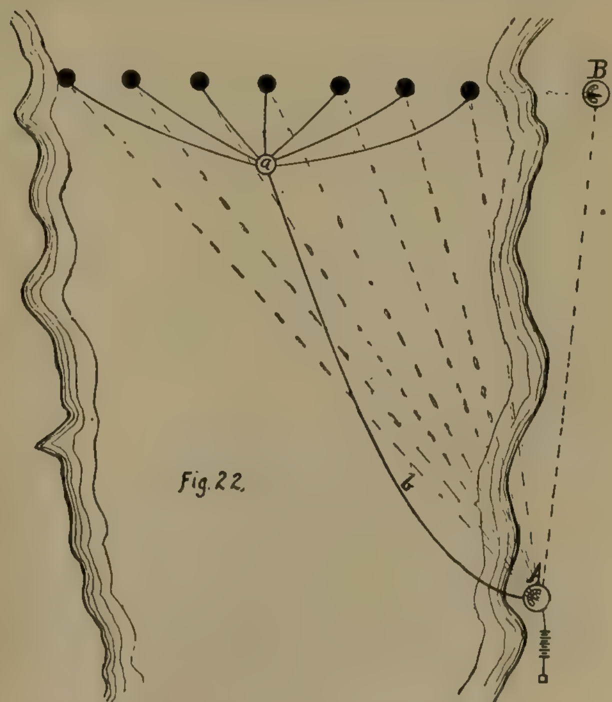


Fig. 22.

sweeping, and launches for countermining. Row-boats would be sent over the field to creep for the cables with properly constructed creepers or grapnels. If not too deeply submerged or too heavy they may be raised and cut; otherwise destroyed by explosive grapnels. Boats in pairs, with drag-ropes or nets between them, would sweep the field for the mines themselves. The counter-

mining launches following would endeavor to attach their countermines and complete the destruction.

It seems more than probable that the electric light will play an important part in this connection in the future. As long ago as 1887 some experiments were made at the naval torpedo station with submerged incandescent electrical lamps. These lamps were from 100 to 150 candle-power, secured to the end of torpedo spars and submerged to varying depths up to about 20 feet. The light was sufficient to render objects within a radius of 100 to 150 feet distinctly visible, and there was little or no glare above the water to betray the presence of a boat.

The use of an electrical light by submarine divers would seem a better method of using this kind of subaqueous illumination. A diver's helmet devised by Lieutenant Scotti, of the Italian Navy, for the purpose of examining the bottoms of ships could very well be used for the purposes of submarine countermining. The lamp used is a 100-candle-power Bernstein. The light is projected in a cone through the thick glass front by a reflector in rear. The current could be supplied by accumulators upon the accompanying launch. Experiments with this lamp indicate that a diver can make his way with ease either over rocky or muddy bottom seeing objects with great distinctness. By igniting the lamp after submergence there was no danger of breaking. The two conducting wires can be enclosed in the air-supply hose.

Ground mines, especially those to be fired by observation, are much less vulnerable to countermining attacks than buoyant ones. They are not only more difficult for an enemy to discover, but more difficult, even when located, for him to neutralize or destroy. In putting down a system of mines to defend a harbor, it is recommended that a fairway be left through the field free from all floating or buoyant mines and defended only by observation ground mines. If the depth of water exceeds 40 feet the charge would have to be rapidly increased with the depth; and at 80 feet, which may be put down as the maximum depth for a ground mine, this would reach from 1,500 to 2,000 lbs. of high-explosive.

Under the most favorable circumstances an attack upon mined waters is difficult and hazardous. Only at night can such operations be undertaken, and even then if the protecting batteries are provided with search-lights and machine guns the chances of success are small, unless resort can be had to a purely submarine attack, as by divers or by submarine boats. The danger of attempting to remove mechanical mines, even by daylight, and with all necessary appliances, was shown by the number of Federal vessels destroyed while attempting to clear the mined waters of Southern harbors after the close of the Rebellion.

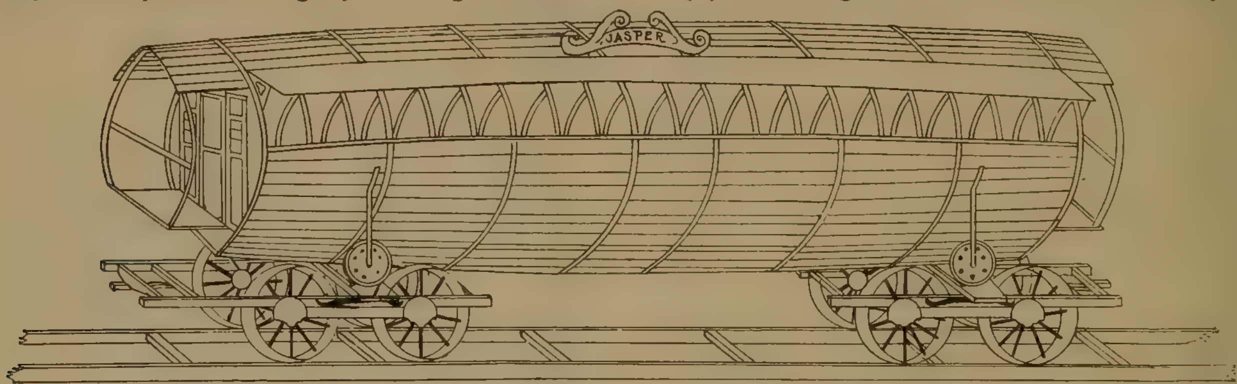
For countermining purposes much is at present expected from the dynamite gun. Captain Zalinski proposes a vessel specially constructed for this work, protected by 5in.-armor and armed with three 15-in. dynamite guns mounted forward, as in the *Vesuvius*; these to carry 8-in. sub-caliber projectiles containing 100 lbs. of high-explosive. A round of three shell will clear, it is supposed, a width of 100 ft. at a discharge. To countermine a channel 7 miles long and 100 yards wide it is estimated that 1,200 shell will be sufficient. The short range of the dynamite gun—from 1 to 2 miles—the presumed presence of shore batteries armed with long-range, high-power rifles, and the very moderate thickness of armor such a vessel would be likely to carry, would seem to indicate that such a craft would be blown out of water long before it came within effective range of its air-guns. If the guns can be maintained within effective distance of the mine-field their ability to open a road can hardly be doubted.

(TO BE CONTINUED.)

## A CURIOUS CAR.

THE accompanying engraving, which is made from a tracing taken from the original drawing, shows a car of a very curious pattern, which was built for the South Carolina Railroad some 50 years ago. The drawing is still preserved among the records at the shops of that Company. An inscription on the drawing shows that this form of car was deemed of sufficient promise to be covered by a patent; it reads: "Patented by George S. Hacker, January 21st, 1841. Patent No. 1937."

No scale is attached to the drawing, so that it is difficult to say just how large the car was; and this difficulty is increased by the evident fact that the draftsman was not skilled in perspective. If we take the end door as a standard, it would make the car about 45 ft. long, and the wheels 51 in. in diameter, which seems hardly probable; it is much more likely that the door and platform are incorrectly drawn.




CAR BUILT FOR SOUTH CAROLINA RAILROAD IN 1841.

The size, however, whatever it was, does not affect the general design. The car-body may be roughly described as a barrel laid on its side, and composed of wooden staves bound with iron. A long opening in the side serves in place of windows, and the end platforms shown in the drawing were probably continued through the car as a floor, although there is nothing to indicate it.

An inscription on the drawing indicates that the car was to be used either for passengers or freight. In the latter case the side opening might be closed, or dispensed with altogether.

The car was carried on two trucks with wooden frames and outside bearings. No center pin is shown on either truck, but it seems as if there must have been one. There are side-bearings very similar to the old Winans roller-bearing, and the springs are under the cross-brace in the center of the truck. The axle-boxes are apparently attached rigidly to the frame. The wheels are of the spoke pattern.

It will be noticed that the draft was from the trucks, no draw-bar of any kind being shown on the car-body.

It would be interesting to know how long this car was in service, what finally became of it, and whether more than one was built.

## THE CELEBRATION OF THE SECOND CENTURY OF THE AMERICAN PATENT SYSTEM.

THE Committee in charge of the patent celebration to be held in Washington on April 8, 9, and 10 announces that, in view of the limited seating capacity of the largest public hall in Washington, it has been found necessary

that admission to the public meetings, at which addresses will be delivered by distinguished speakers, will be by ticket only. This rule will also hold for the public reception to be given at the Patent Office and for the excursion to Mount Vernon. Persons desiring to attend the meetings and participate in the reception and excursion should make application at once to J. Elfreth Watkins, Secretary of the Executive Committee, 811 G Street N. W., Washington, D. C.

The programme issued by the Committee is as follows: April 8, afternoon, first public meeting, to be presided over by the President of the United States; evening, second public meeting, to be presided over by the Secretary of the Interior; evening, 9 P.M., special reception to inventors and manufacturers at the Patent Office by the Secretary of the Interior and the Commissioner of Patents.

April 9, afternoon, third public meeting, presided over by Hon. Frederick Fraley, of the American Philosophical Society and the Franklin Institute; evening, fourth public meeting, to be presided over by S. P. Langley, Secretary of the Smithsonian Institution.

April 10, special anniversary day, being the anniversary of the signing of the first American patent law. In the morning there will be an excursion to Mount Vernon, where an address will be delivered by Dr. Toner, of Washington. In the evening the fifth public meeting will be held, to be presided over by Professor Alexander Graham Bell.

Among the distinguished gentlemen who have promised to make addresses at the different public meetings are: Edward Atkinson; Dr. John S. Billings, U. S. A.; Judge Samuel Blatchford; Mr. O. Chanute, President of the American Society of Civil Engineers; Senator J. W. Daniel; Professor Thomas Gray; Mr. A. R. Spofford, Librarian of Congress; Professor R. H. Thurston; Professor William E. Trowbridge, and a number of others.

The general and local committees have expended a great deal of labor on the arrangements for the celebration, and it is expected that they will be very complete.

On the afternoon of April 7 a meeting will be held to organize the National Association of Inventors & Manufacturers, and other meetings will be held later as opportunity is afforded. A number of prominent gentlemen have agreed to join in this proposed Association, and addresses from some of them may be expected at the meetings.

## OUR NAVY IN TIME OF PEACE.

By Lieutenant Henry H. Barroll, U. S. N.

(*Continued from page* 117.)

THOSE naval duties heretofore considered have been of a nature which may be classed as entirely military; and although pursued in time of peace, are yet such as render it a more perfect defense to the nation in time of war. When the nation is at peace, however, the Navy can and does in various ways further the maritime interests of the country.

It is the duty of all civilized nations that each shall take its part in the policing of the sea. A hundred years ago the ocean was swarming with pirates where now thousands of vessels are peacefully sailing in the pursuit of commerce; and these seas would again be terrorized by pirates were it not for the navies of the world. True, the age of steam has made it impracticable for these gentlemen of the sea to continue their depredations so boldly as in former times, but long before steam vessels came into general use the pirate's doom had been practically sealed; while if the several nations should now withdraw their cruising ships, pirates would soon reappear, and could easily supply themselves with coal from captured steamers.

In time of peace the presence of one of our vessels in a foreign port, instead of being regarded as a menace, serves to intensify the friendly relations already existing between the two powers. The recent visit of the White Squadron to the newly established Republic of Brazil created a good impression, and that nation lost no time in sending a squadron to our waters, thanking the President for the courtesy shown.

Our foreign squadrons, instead of making these special visits, are at all times exhibiting our flag in foreign waters, extending to all quarters of the globe a knowledge of our manufactures, and strengthening the friendships already existing between the United States and other powers.

The most distinguished instance of the good effect of this branch of naval occupation is the expedition made to Japan, in 1853, by Captain M. C. Perry, U. S. N., and which resulted in giving to the civilized world the companionship of a people who are now recognized to be one of the most intelligent, refined and progressive of existing nations. In 1882 Commodore Shufeldt, U. S. N., in like manner formed a treaty with the hitherto exclusive Korean nation, which, with its 8,000,000 inhabitants, has now opened its harbors to vessels bearing American manufactures, the sales of which are each year rapidly increasing.

During peace a vessel cruising on a foreign station is not likely to interfere in the execution of that nation's laws, yet there are times when the mere presence of an American vessel in a foreign port will avert the oppression or maltreatment of one of our citizens there engaged in business.

### SURVEYING AND DEEP-SEA SOUNDING.

To the Navy properly belongs the province of surveying or mapping out the different great oceans and their shorelines. In this work all civilized nations have assisted, each generally surveying, in addition to its own shores and waters, a portion of those under semi-civilized or less enterprising governments.

Considering that our nation has had but little more than one hundred years of existence, we have thus far fully performed our share of this duty; and to-day the United States is cited by other nationalities as possessing the most complete and efficient system for collecting and distributing hydrographic information.

Owing to the establishment of the U. S. Coast Survey as one of the sub-departments of the Treasury, instead of the Navy Department, naval surveys cease when we reach our own shores; although the hydrography here is still mainly executed by officers and seamen temporarily transferred from the Navy to the Treasury Department for that purpose.

Foreign surveys executed by United States naval vessels have mainly been made along the coasts of Mexico, Central and South America, China, Japan, Corea, the Pacific Islands, and the coasts of Africa, etc., while for our knowledge of the more advanced European countries, we depend upon surveys made by themselves — engraving plates from the charts which these other countries have published.

All of the principal nations of Europe have been prominent in the charting of the earth's surface; and there are now few parts of the globe which are not covered by comparatively well-constructed charts.

Among nations, Great Britain has done the largest amount of hydrographic surveying; and to this is partly due the superiority of her ocean commerce over that of other nations. The British Hydrographic Office now publishes about 3,000 different charts and 100 books of sailing directions, covering all quarters of the globe, showing the best routes and channel-ways that exist across the seas and into all known harbors, and clearly marking the various dangers to navigation.

In the earlier days of our nation the people of the United States, in order to navigate even our own coasts, were dependent upon charts printed in England, and the plates of which were always retained there. In recent years, however, the United States has made great strides in this work, and now stands a close rival to England in the amount of aid given to navigation.

### THE HYDROGRAPHIC OFFICE.

In 1830 there was founded a depot for the collection and preservation of charts, chronometers and other nautical instruments belonging to the Navy, and for the collection and distribution of maritime information. This depot was the foundation of the present Hydrographic Office and of the Naval Observatory. Lieutenant L. M. Goldsborough, U. S. N., was appointed as first Superintendent

of the "Depot," as it was then designated, and it has ever since been under the direction of the Navy Department.

The hydrographic and astronomical duties of the Depot became of such diverse natures that their combination under one management was no longer practicable. In 1866 a division was made, since which time the two institutions have had separate superintendents. Both institutions are under the direction of the Bureau of Navigation.

The United States Hydrographic Office now publishes about 1,300 charts of foreign coasts and harbors and over 100 different volumes of sailing directions, besides annually distributing, for the benefit of navigators, tons of printed information.

These items of information thus distributed vary greatly in character. In addition to the production of charts, with accurate soundings and shore-lines, there are numerous other points which serve to assist a navigator in traversing unknown waters.

While the traveler on shore may use his sense of sight in avoiding the dangers or obstacles which beset his pathway, the mariner must mainly trust to precarious soundings to indicate to him the profile of the ocean's bottom—the greatest of all dangers.

The bottom of the sea, like the land surface of the earth, is continually changing; and therefore the survey of a harbor or channel-way, although comparatively accurate at the time of its execution, is not necessarily so for all time. Along the Atlantic coast of the United States, for example, the permanency of surveys is extremely poor; and such localities as Hatteras, Lookout, and Frying Pan Shoals, as well as the sand-bars at the entrances of many of the Southern ports, should be resurveyed at least every five years, since in less than that period these shifting sand-spots entirely change in contour.

The wrecking of a steamer upon a shoal, as, for example, that of the British Steamer *Aberlady Bay*, recently stranded upon Lookout Shoals, will in a very short time cause a complete change in the shoals themselves, and their numerous dividing or "slue" channels.

In time of peace, while cruising on foreign stations, there is no better employment for naval vessels than that of discovering new shoals, reefs, etc., or in carefully surveying those shoals and channel-ways whose actual limits are till now but comparatively little known. The surveys are generally made by vessels doing duty on foreign stations, but in some cases, as, for example, the Wilkes Exploring Expedition, in the *Vincennes*, and the Survey of the River Amazon, by Selfridge, etc., vessels are specially detailed for surveying duty.

Although this work is constantly going on, yet, on the other hand, new dangers and obstacles are constantly being discovered, even along routes and in localities which have been for years considered clear of such obstructions. Breakers, shoals and reefs are continually being reported, especially in those sections of the ocean where it has hitherto been impracticable to make other than superficial surveys; and vessels are constantly being sent to search for these reported dangers, to eliminate erroneous reports from correct ones, to determine the exact position and extent of this danger, or else to show absolutely that it does not exist. Frequently the more careful examination of the locality in question proves that that which had been reported as a line of breakers or shoal water must have been the gleam of the sunlight upon the water or the shadow of a passing cloud.

Sea-weed and drifting wreckage have been reported as sea-serpents. In the same way, the ocean abounds with many supposed dangers to navigation which only need closer inspection to prove them harmless.

The settlement of these doubtful dangers, by either placing them accurately upon or entirely expunging them from the chart, is of great importance. The navigator feels more security when he knows that a careful search for that particular obstacle has determined its non-existence or has located it as existing at a certain definite point.

The noting of all changes that occur, the search after undiscovered dangers and the determination of doubtful reports may be called the Care of a Chart, and corresponds to the cleaning and oiling of an engine or the scraping and painting of the metal plates of a modern ocean steamship.

Notwithstanding the care taken in correcting and perfecting ocean charts, the increased number of vessels engaged in ocean traffic, the greater speed at which they now travel and the desire of all nations to extend their commerce to more remote localities, require that to meet these conditions greater accuracy must be attained in chart-making. More vessels, greater competition and quicker passages directly attack the safety of ocean travel; and this state of affairs must be compensated for as much as possible by withdrawing all other sources of danger.

There is little resemblance between the exact navigation of to-day and the hap-hazard voyages of those hardy explorers Hendrik Hudson, Magellan, Gosnold, and Da Gama; or the successful piratical raids of that old freebooter Sir Francis Drake. One hundred years ago the libraries of the world did not contain as much information with regard to the sea as is now annually gathered by the hydrographic office of a single great nation.

With charts that are nearly perfect and with accurately established light-houses, beacons, buoys and other appliances for assisting navigation, it would seem that travel by sea was at this day sufficiently protected.

People still speak of the "trackless ocean," but routes by sea are now intelligently alluded to, exactly described and accurately laid down, the same as trunk lines of railroad are discussed or utilized by the shipper or commercial traveller; and the province of the navigator is now confined to keeping the safest or the shortest known route.

This, by the way, is hardly ever that line which upon the ordinary chart appears to be the shortest distance. For example, for a sailing vessel bound from Gibraltar to New York, the shortest route would be southward and east of Madeira, to a point in long. 30°, lat. 22°; thence along that parallel to long. 60°, thence northward, and west of Bermuda to the Gulf Stream, by which to the vicinity of New York. In point of time, the longest course across the Atlantic would probably be represented on the chart by the line which joins these two places.

Even in the case of a steamer which does not have to depend upon the winds for motive power, the straight line, as shown upon an ordinary Mercator's chart, does not represent the shortest distance between two places. This least distance is measured on the arc of the great circle upon which both places are situated. The shortest distance between Cape Henry and Liverpool, for example, crosses the middle of Newfoundland.

Each nation now vies with others in making the approaches to her ports as secure as possible; and while we spend millions of dollars in the improvement of our harbors, care should be taken to point out existing danger or to publish the fact that the road is a safe one.

The master of a vessel when starting upon a voyage into foreign waters cannot be too well supplied with maritime information. Although the aids to navigation, in the shape of charts and buoys, etc., are now so complete, yet when entering the waters of a strange locality guide-books should be on hand, filled with as complete a description of that place as can be obtained; once arrived in that locality, there is no time to pause for further knowledge; he cannot telegraph to the rear for additional information. All the help that the master can depend upon is that information carried aboard of his own vessel; and this he studies carefully as his vessel approaches an intricate or unfamiliar channel.

Anything is of importance which enables the navigator to make a speedier or a safer passage; for upon these points depends the prosperity of the voyage.

Under the general title of "Sailing Directions" are included all items of information that assist the master of a vessel in making his voyage, ensure the sale of his freight, or give him a better chance of securing a profitable return cargo.

"Sailing Directions" not only state the courses to be steered from one port to another, but describe the prevailing favorable or contrary winds and currents; ice-fields, or other dangers likely to be met on certain courses; tides; depths of water at the entrances to various ports, etc., as well as hundreds of other items of information which may add to the security of the vessel and the quickness of her cruise.

The localities where coal, water, wood, etc., may be procured in the foreign harbors to which he is going ; the number and nature of the inhabitants—whether hostile or friendly ; the mercantile products that are exported or desired ; the best places to anchor, and the facilities for discharging or taking cargo aboard ; the periods of the year when local or general gales may be expected—indeed, everything that may add to the knowledge of the navigator, so far as this particular locality is concerned, and which cannot be graphically represented upon the chart is included under the descriptions given in "Sailing Directions."

A complete list of the books showing this information for all parts of the world would be too cumbersome for any vessel to carry and too expensive for the masters of vessels to provide. These books themselves are also subject to the same continual change as are the charts covering the same localities. It is not customary, therefore, for ship-masters to keep copies of sailing directions too long on hand. In many cases it is the custom for ship-owners to provide all such help for the ship-master.

### BRANCH HYDROGRAPHIC OFFICES.

Owing to the great area of the United States, and the difficulty there would be in obtaining the most recent corrections for charts or sailing directions, branch hydrographic offices have been established in the larger seaboard cities, where are kept complete lists of charts and a full library of all sailing directions. Here the ship-master can depend upon obtaining at all times the latest and most reliable information concerning any port with which he may not be familiar.

Should he have a copy of the necessary chart or book of directions, it can be here compared with the office copy of the same, which latter is constantly kept corrected by the insertion of the very latest received information.

The branch hydrographic offices are located at Boston, New York, Philadelphia, Baltimore, Norfolk, Savannah, New Orleans, San Francisco, and Portland, Ore. The charts and books kept here are not for sale, but for reference, and also in order that the officer in charge of the office may be able to give clear and exact information on any maritime subject.

Here is also kept a file of the Notices to Mariners which are constantly being issued with regard to reported dangers, etc. The data for the publication of these notices is here collected and forwarded to Washington, where, after being arranged and printed, copies are sent to all branch offices, from which as centres the information is distributed.

When a change is made in either the character or position of regular aids to navigation, or when information is received of danger existing in the pathway of vessels, a short account of the same is printed under this title of "Notice to Mariners," describing such change or obstacle, and stating what should be done by mariners to avoid trouble from the same. The notice also generally states what steps, if any, are going to be taken to remove this obstruction.

The temporary derangement or discontinuance of a light-house, or the establishment of a new one ; the drifting or destruction of any of the various buoys or beacons ; the discovery of a shoal or of a superior channel to the one hitherto known and used ; the establishment of a new port of entry ; wrecks, floating, or sunken in channel-ways, and the placing of buoys to mark new dangers or new channels, are among the many causes which require the issue of such notices.

The hydrographic offices of various nationalities interchange such information, and, therefore, since many notices are received couched in a foreign language, their translation into English is necessary before they can be reissued for the benefit of our merchant marine. In 1890 the United States Hydrographic Office issued 1,171 such notices, covering all parts of the world.

Each branch office is under the charge of a naval officer, who sees that all important information, especially that relating to his immediate vicinity, is at once furnished to steamship companies, shippers, etc., whose interests are thereby affected.

In addition to its publication of charts and the writing, arranging and publication of sailing directions, notices to mariners, etc., the Hydrographic Office also publishes from time to time other valuable data, such as Ice charts, Pilot charts, Meteorological charts, abstracts of storms and monographs of the more serious meteorological disturbances.

### DEEP-SEA SOUNDING.

All of our knowledge of the profile and general character of the bottom of the great oceans has been obtained through the medium of deep-sea soundings. By this term is now meant soundings in depths greater than 600 ft.

The operation of laying submarine cables is greatly dependent upon the accuracy with which the profile of the ocean's bottom can be ascertained. The principal difficulty in laying ocean telegraph cables is found to be the danger in great depths of breaking either the cable itself or the insulated covering during the operation of "paying out." After the cable has once reached bottom it has to withstand comparatively little strain.

In order to obtain accurate soundings in great depths, it is necessary to use line of a density that will not counteract the efforts of the sounding-weight. What is desired is an "up and down sounding," as near as may be obtained. A line made of manila or other buoyant substance would not serve for this purpose.

On the other hand, the upper part or surface end of the line used in sounding has to support not only the strain of the sounding-weight, but also of the sounding-line itself, that part of its weight which is not water-borne.

It can thus be seen that at great depths, yet possibly before the weight or cable had reached the bottom, the sounding-line or telegraph cable might break merely from the weight of line that had been payed out. The sounding-weight becomes a matter of small importance, in comparison with the weight of the line itself.

Early attempts at sounding great depths depended, therefore, upon the manufacture of line of great tensile strength and of disproportionately light weight.

An early form of sounding apparatus was that invented by Passed Midshipman Brooke, U. S. N. (afterward Lieutenant Brooke, and the inventor of the Brooke rifled cannon). This apparatus contained the main principle upon which are constructed the more elaborate sounding-machines of the present day.

The Brooke sounding apparatus was in its action similar to the modern hooks used for transporting blocks of ice, and which detach themselves when relieved of the weight they are supporting.

It consisted of three principal parts—a register, a rod and specimen tube, and a detachable "sinker." The register, which was attached directly to the sounding-line, contained two spiral propellers, which, being turned by the water, recorded by clock-work the amount of descent. The rod and specimen tube had at the upper part a hinged link, which permanently joined it immediately underneath the register. The lower end of the rod was a tubular space, in which were vertically fixed a number of goose-quills, which received and brought to the surface specimens of the bottom. The sounding-weight or sinker was a perforated spherical shot resting in a washer supported by wire slings.

After the rod and specimen tube had been inserted through the shot and its supporting washer, the wire slings were brought up and hooked over a small lug upon the hinging link, where they remained secure until the point of the rod touched the bottom, when they immediately unhooked, and sinker and washer were left behind, the register and rod being easily reeled again to the surface.

Many improvements have been made in deep-sea sounding apparatus, notably by Sir William Thompson, F.R.S., and by Commander C. D. Sigsbee and Ensign Harry Phelps, of the United States Navy ; and now the greatest known depths are accurately sounded by steamers such as H. M. S. *Challenger* and the U. S. Steamers *Blake* and *Ranger*, that are fitted with the regular modern appliances for deep-sea sounding.

The sounding-line now used is steel piano-forte wire, which, while weighing only about 7 lbs. to the mile, will bear a strain of 400 lbs. without breaking. The amount of descent of the sinker is now shown on the ship's

deck by means of a register attached to the wire-reel, and which records each turn made. A small correction is necessary for the constantly lessening diameter.

The sinker may also be arranged in such a manner as to be undetachable, in which case it is recovered after the sounding has been made. The sinkers vary in weight according to the anticipated depth, while the reeling in is now done by a small engine conveniently placed on deck for that purpose.

With the many modern improvements, it is now possible to take deep-sea soundings with ease and celerity. Ensign Phelps, U. S. N., of the U. S. S. *Ranger*, while using the machine perfected by himself, easily obtained soundings in 650 fathoms with a 40-lbs. lead sinker, the ship starting ahead at a speed of 7 knots as soon as bottom was reached, the reeling in of the wire continuing while under way, and the wire coming in at the rate of about 150 fathoms per minute.

In the North Atlantic, the Caribbean Sea and the Gulf of Mexico our vessels have done much deep-sea sounding, which has greatly increased our knowledge of the various ocean currents in those localities; while several attempts at deep-sea trawling have been quite successful, many specimens of shell-fish and marine plants hitherto unknown having been secured.

To take accurate soundings in depths of from three to four miles, is now a matter of frequent occurrence, and in even greater depths soundings have been obtained.

(TO BE CONTINUED.)

## CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

### CHEMISTRY APPLIED TO RAILROADS. XV.—HOW TO DESIGN A PAINT.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.



(*Continued from page* 82.)

OBVIOUSLY the designing of a paint involves sufficient knowledge to answer three questions: First, what kind of pigment shall be used; second, what kind of binding material shall be used; and third, in what proportions shall the pigment and the binding material be mixed?

To those who have not given much study to the question of paints it may seem as though the answer to the question, "What pigment shall be used," is exceedingly simple. The simple answer would be, decide what color you want and then use a pigment which will give you that color. If red is the colored desired use some one of the reds for the pigment; if yellow is the color desired use some of the yellow pigments; if blue is the color desired use a blue pigment; if brown is the color desired use a mixture of red and black; if green is the color desired use a mixture of yellow and blue; and if a gray or a slate color is desired tone some white with enough of the proper material to give the shade desired, and so on.

But to those who have studied paints a good deal the matter is nothing like so simple. There are a good many questions to be considered in deciding what pigments to use. All pigments do not work equally well under the brush, and all pigments do not dry equally well. Many pigments when mixed with binding material do not behave as it would be thought beforehand they would behave. Many of them are deficient in covering power and devices have to be made use of to overcome this difficulty, and, perhaps more important than anything else, all pigments are not equally durable. With many of them there is apparently a chemical reaction which takes place between the oil and the pigment after it has been on the surface a while, which results in the perishing away, or in the scaling or peeling of the paint. Furthermore, some pigments repel water and some pigments do not. Some pigments grind well and some do not, and, finally, some pigments are extremely expensive while others are very much less so.

In view of these statements it is obvious that the selection of the pigment in a paint to be used generally is not so simple a matter, and that in order to do this work intelligently and wisely, and secure good results at the least possible expense, an intimate knowledge of pigments is essential. Our experience with pigments has been more limited than we could wish, and we do not at all feel that we should be able to convey in the present article information sufficient to enable one unskilled in the art to use all pigments wisely in making paints. We do hope, however, to be able to give one or two laws which, so far as our experience goes, have pretty broad if not universal application.

It will be understood that the ground covered by this article is confined almost exclusively to house-painting. In carriage-painting, the use of pigments is almost exclusively for the sake of the color, and the use of the binding material is simply to hold the pigment to the surface. Questions, therefore, of durability or economy are very much less important in carriage-painting than in house-painting, where the paint is relied on not only for the color but also for protection, and where its expense must be likewise carefully considered.

It will be remembered that in the articles which have preceded we have discussed (1) the durability, (2) the working qualities, (3) the drying, and (4) the covering power of paints, and have tried to set forth in those articles what we regard as essential under the various heads. All these four properties are essential in order to have a good paint. There is a fifth quality which must not be forgotten, and especially in the discussion which we are about to enter upon, and that is (5) the cost. What is really wanted from the standpoint of the consumer, at least, is that the paint shall have the four qualities mentioned above, at the very minimum of cost. In what follows we will try to bear in mind each of these five essential requisites.

In answering the question, What pigment shall be used, the subject naturally divides itself into two branches, namely, first, where pigments of the color desired, and which fulfil the five requisites mentioned above, can be obtained in the market, and, second, where the desired colors cannot be obtained in pigments which fulfil the five requisites above. As examples of the first of these cases we may mention the various shades of red produced by the numerous oxides of iron, also the yellows produced by the ochres, the browns produced by the umbers and Siennas, and the blacks produced by ivory black and lamp-black. With a modification which will be discussed at some length a little farther on we will say that where the color desired is so simple as any of the above, or where a pigment which has the proper durability, working qualities, drying properties, covering properties, and cost can be found of the desired color, the choice of the pigment is extremely simple, and the answer to our question of what pigment shall be used is not at all difficult to find. But with a very large portion of the paint used, exclusive of carriage-painting, the question is nothing like so simple as this, since the shades desired cannot be found embodied in a single pigment which satisfies the five requisites. To answer the

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number on the Covering Power of Pigments. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION of special value in indicating the true character of the materials they must use and buy.

question as applied, therefore, to tints and shades, which is a large percentage of all the painting, it will be necessary to go a little deeper.

There is, however, one preliminary question which must be discussed before we can enter on this field, and that question is, "Is it necessary and wise in painting to use pigments as pure and unmixed with any other materials as it is possible to get them, or with various pigments can a certain amount of inert matter be wisely used as a constituent?" For example, is it wise and essential when using red lead as a pigment to have the pigment all red lead? Is it wise and essential when using white lead as a pigment to have the pigment all white lead? Is it wise and essential when using oxide of iron as a pigment to have the pigment all oxide of iron, and so on? We have studied this point a great deal and have made a large number of experiments, and the successful answer to this question, it seems to us, involves still another question, namely, if the pigment is strong in coloring power, as is the case with oxide of iron, with lamp-black, and with other pigments which might be mentioned, is it better to dilute with liquid and thus make a given amount of paint cover a larger amount of surface, or is it essential for the durability and success of paints that the surface should be covered with a large amount of pigment. It is obvious that if with a given amount of paint of oxide of iron or lamp-black a very much larger amount of liquid is mixed in one case than another a very much larger amount of surface will be covered in one case than in the other, and it is also obvious that the amount of pigment per square inch or square foot will be very much less in one case than the other. We have known very many practical men to claim as one of the advantages of the material which they furnish that it would bear dilution of this kind with liquid and still cover the surface well. Our experience confirms this statement, namely, some of the oxides of iron are so strong in covering power that they can be very largely diluted with liquid and still cover the surface excellently well; but the query arises, Is the surface as well protected, and will a paint of this kind, namely, one in which the amount of pigment per square inch or square foot of surface is small be as durable and as satisfactory in other respects as one in which the amount of pigment per square inch or square foot of surface is very much larger? To this question we answer emphatically, It will not. All our experience and experiments for now some three or four years, show conclusively that the amount of pigment per square inch or square foot of surface is one of the elements in the durability of the paint. Freight cars painted with 25 lbs. of freight-car color paste look well and have a good coat of paint on them at the end of three or four years, while cars painted with 12 to 15 lbs. of freight-car color paste begin to look badly at the end of the second year and the layer of paint is thin and the car has an old and worn appearance. We have very little hesitation in saying, and we think all experiments honestly made under proper conditions will prove this point, namely, that it is essential for a good paint that the amount of pigment per square inch or square foot of surface should be large.

This may look like making the durability of the paint depend on the pigment, whereas the common idea is that the oil is the life of the paint. We are quite free to confess that in our experience we have not been able to confirm the common belief among paint manufactures and, indeed, among many of the users, that the oil is the life of the paint. The pigment is the life of the paint according to our experience. In reality the pigment protects the oil from decay if it is present in proper amount and, still further, is of the proper kind. A single thought seems to us to have very much weight in this connection, namely, with such pigments, for example, as oxide of iron, which undergo no chemical change in centuries of exposure, it is obviously the oil which decays and wastes away. Even though the pigment has fallen off from the surface it is still oxide of iron and is unchanged. Not so with the oil, it is constantly undergoing slow decomposition, and in reality the wear and wasting away of paint is largely the decay of the oil. This statement, of course, only holds true where there is no chemical action between the oil and the pigment. These cases we will treat farther on. It is sufficient for our purpose here to put clearly on record that we regard it as an essential of good paint that the amount of pigment per square inch or square foot of surface should be large. We will, later on, when we come to discuss the question of the relative proportions of oil and pigment, give some figures on this point.

If this statement be granted, we are now ready to discuss the other question, namely, although it is essential that the amount of pigment per square inch or square foot of surface should be large, is it essential that this pigment should be all of the characteristic kind that is used to give the color desired? For example, although it is essential to have a large amount of pigment on the surface painted with oxide of iron, is it essential that all, or nearly all, of the pigment should be oxide of iron? We unhesitatingly say, It is not, and are quite aware that in making this statement we are laying ourselves open to the accusation that we are opening the door to all kinds of adulterations and admixtures and inferior results in paints, but we do this with our eyes wide open. We are confident that it is not essential to use pure pigments, except as will be mentioned later on. We believe greater durability, fully as good working qualities, equally good drying qualities, sufficiently good covering power, and diminished cost can be obtained by mixing inert materials with other pigments where they will stand it than will be obtained by using as pure materials as can be obtained in the market. For example, it is well known by those who have spent any time on this subject and made any experiments, that if any good oxide of iron is mixed with sulphate of lime, carbonate of lime, barytes, kaolin, silica, talc, or pulverized feldspar, in the proportions of about $\frac{1}{4}$ oxide of iron and $\frac{3}{4}$ of any one of the above inert materials and a paint made of this which gives the proper amount of pigment per square inch or square foot of surface, the surface will be well covered with the red, and the same thing is true, in a modified way, with a number of other pigments which are strong in covering power. To state the problem again, we will say that the real question seems to be, first, suppose one ounce of oxide of iron, in two coats, will cover two square feet of surface so that the surface will be completely hidden, and any painter would pronounce the job a satisfactory one so far as covering power goes; second, suppose now a contiguous two square feet had one ounce of the same oxide of iron on it, but in addition it had three ounces of inert material, such as barytes, gypsum, kaolin, etc., or any one of them mixed with the oxide of iron, the whole being spread in two coats as before. Obviously the amount of color per unit of surface would be the same in both cases, but in one case there would be four times as much pigment as in the other, and in the second case three-fourths of the pigment would be inert material. We say the question is, which of these two paints would have the greatest durability? We have no hesitation in saying that the second one would, and all our experiments confirm this view.

We are thus explicit in stating this point because, as said above, many manufacturers and many painters hold diametrically opposite views. They think pure materials alone should be used, but as we will try to show later, there are very great disadvantages connected with the use of certain pure materials, which disadvantages are modified by the use of inert material along with the pure pigment. We are quite well aware that this opens the door for adulterations so called, but our answer to this is that when people become so informed on the subject that their demand for absolute purity has passed away, for the reason that better paints are obtained by using durable inert materials as constituents than by using perishable pure materials, then there will be no adulteration, because the manufacturers will sell their paints exactly as what they are. They will not claim to sell pure paints, but will give the formula if it is cared for. Moreover, as long as a man knows what he is buying, and is not charged the price of pure materials for mixed materials, there is no adulteration.

This question of inert materials is so important in our judgment, that we may be pardoned for devoting a little space to it, as we are quite prepared to believe that a very large number of people interested in painting would hardly be willing to accept our first proposition, namely, that greater durability and less cost, with no detriment to working

properties, drying and covering qualities, can be obtained with the use of inert material along with the pigment than if this pigment is used pure and simple. However, we are so well satisfied upon this point that we are ready to discuss one or two questions connected further with inert materials, namely, first, What inert material shall be used and, second, how much of it shall be used? At present there are available in the market seven or eight different kinds of inert materials, as follows: Whiting, ground gypsum (also known as American terra alba), barytes, kaolin (or pipeclay), ground silica, ground talc, ground feldspar, and possibly asbestos may be added, although according to our experience much of that which passes as asbestos is nothing in the world but ground talc, or some related rock. We have experimented with each of these inert materials more or less and find them all extremely deficient in optical covering power; indeed, a board painted with any one of these ground into a paint looks almost the same as though it was not painted at all so far as optical appearance or behavior is concerned. They are all whites, as is well known, except as they may be contaminated more or less with a little oxide of iron or other minerals imparting a little color or tint to them. Taking them up one after the other we will give a few points in regard to them. Asbestos of the fibrous nature we have never seen in paint of any kind and have very little experience with it. As said above, most of that which passes as asbestos is ground talc, or soapstone, or some related rock, so far as our knowledge goes. Feldspar we have never felt inclined to largely use on account of its ready decomposition when exposed to the weather. It is recognized that many of the clay beds of the country now used for making fire-brick are simply decomposed and broken down feldspars, and a pigment, or anything in a pigment in paints, which is not durable and unchangeable when exposed to the weather, is certainly to be avoided. Talc we have experimented with quite a little and find that it does not grind well, and in almost any proportion with any pigment with which we have mixed it it makes a paint which does not seem to adhere well. It is in this respect much like kaolin, which all practical painters say grinds greasy, and while in many senses both kaolin and talc are valuable and may be used in special cases, especially where the main pigment is inclined to be granular, we do not recommend either of these very highly. Ground silica, so far as our experiments go, is unobjectionable, except that it is very hard on the mill, and difficult to get in a fine state of division, which is one of the great essentials of a good paint. This leaves barytes, gypsum, and whiting. So far as barytes is concerned, we simply say that we have no objection to it except its great specific gravity and its cost. A pound of barytes will go a very little distance in a paint. Obviously if paint is bought and sold wholly by the pound, it is very advantageous to the manufacturer to use as much barytes as possible, but the use of paints is by volume and, consequently, it is very disadvantageous to the buyer to have so heavy a pigment a constituent of the paint which he buys. There are many valuable qualities in barytes, especially its great durability, but we query whether the paint manufacturers themselves fully understand what they are dealing with when they use barytes. Our position is that we cannot afford to use it, and we will make the statement that no manufacturer who sells his paint by the gallon can afford to use it either. Of course, if he sells his paint by the pound he can afford to use it; but not otherwise, and to the trade we would say, if you will give us the same number of particles of barytes of the same size, for the same money, that you will of sulphate of lime, or whiting, you may use barytes in making our paints. How impossible this is may readily be seen from knowing that each particle of barytes weighs twice as much as a particle of the same size of sulphate of lime, or American terra alba, and costs fully twice and possibly three times as much. As a suggestion to those who are selling ready mixed paints, we would say, calculate the cost of a gallon on your present formula, if you are using barytes as inert material, and then calculate the cost of a gallon, substituting American terra alba, or gypsum for barytes, and we are confident the use of barytes as inert material in mixed paints, at least, will entirely disappear.

In our discussion of inert materials this leaves us now only two substances, namely, whiting and gypsum, both of which have valuable qualities and both of which have difficulties connected with them. We have thus far always favored the use of gypsum instead of whiting, although we are quite well aware that a number of manufacturers prefer the whiting to the gypsum. We do not feel quite satisfied to say anything very positive in regard to whiting as yet, for our fear has always been of chemical reaction between the oil and the whiting, resulting in the formation of a lime soap, which is not at all durable. On the other hand, putty, which is a mixture of whiting and oil, is an extremely durable substance. We have experiments in progress, but not yet ready to gather conclusions from, as to the relative durability of sulphate of lime or gypsum and whiting as constituents of paints. Within a year or two we will probably have positive information as the result of experiment, but at present the best we can say is that we are afraid to have whiting a large constituent of any paint. This brings us down to sulphate of lime and, all things considered, we know of no material which has so many good qualities and so few difficulties connected with it as sulphate of lime. The only objection to sulphate of lime is the fact that it is a hydrated material, that it has as a part of its chemical composition two molecules of water. During grinding the heat caused by friction is sufficient to drive off a portion of this chemically combined water, and if perchance this water is taken up again before the paint is spread there is a tendency on the part of the paint to become a liver, a phenomenon which is familiar to all old painters. We hope ultimately to discuss the livering of paint somewhat at length, and will only say here that, with the single prerequisite that a little water should always be added to the paint during grinding, where sulphate of lime is an important constituent of the paint, we know of no difficulties which will arise from the use of sulphate of lime as an inert material in paints. Much could be said in its favor, especially its great durability, its chemical inactivity, and its very light specific gravity, and its low cost.

This brings us to the question of how much inert material shall be used. Of course this question is an extremely difficult one to decide. In one case which we have already mentioned we are quite ready to allow as much as three parts of inert material to one part of the characteristic coloring matter. It is obvious, however, that this rule would not be universal, and it is likewise obvious that each pigment has its own characteristic amount of inert material that it can bear. We have obtained excellent results in covering with lamp-black one part and sulphate of lime nine parts by weight. On the other hand, with some of the pigments one part of inert material and one part of the characteristic pigment do not give satisfactory results, and some pigments will not bear any.

The law as we understand it is this: You may use as much inert material as will leave you good optical covering power when the paint is properly mixed and applied. In our experience white lead alone will not bear to be mixed with inert material in equal parts. This also is the case with white zinc. Unfortunately we have not experimented with all pigments and cannot give proportions for all pigments, but there are other points which must be kept in mind. First, the amount of inert material which can be used depends on the fineness of the grinding. The finer paints are ground the more inert material can be used without seriously interfering with the covering power, and those pigments which in their nature are extremely fine will bear more inert material than those which are not fine. Second, the amount of inert material which can be used depends, all other things being equal, on how the paint is mixed. If the paint is so mixed that the coat is very thin less inert material can be used than if the paint is so mixed that the coat is thicker. When we come to discuss the relative proportions of pigment and liquid we will give our experience and practice on this point. The third point is, no inert material must be used which has a possible chemical reaction between itself and the main pigment. Upon this point the information is not as definite as could be desired. We have experimented with mixtures of sulphate of lime and white lead, but are not absolutely positive that any chemical reaction takes place. We have also experi-

mented with white zinc and sulphate of lime, but are unable to prove that chemical reaction does take place. It is well known that chrome yellow, and mixtures of chrome yellow and Prussian blue giving a green, fade readily. We have never fully satisfied ourselves as to whether this fading is due to reaction between the inert material and the other pigments, or between the pigments themselves, or between the oil and the pigments, but it is obvious that if it is possible for any chemical change to take place between the inert material and the other pigments that inert material should not be used with those pigments.

We have taken so much space in discussing the inert material that we have left ourselves only small room for answering the question, "What pigment shall be used?" We have already, however, fairly well, we think, covered the ground where a pigment of the desired shade can be obtained. We will, therefore, only say here that in these cases the rule is that where the pigment which gives the desired shade can be obtained, be it oxide of iron, ochre, umber, Sienna, or what-not, use these pigments and add to them as much inert material of the proper kind as they will bear, due regard being given to the optical covering power. The question of tints for which there is no characteristic pigment remains still to be discussed.

Upon this point we will say that the basis of all tints must be some pigment which has good covering power, and in delicate tints must necessarily be a white, since in all the pigments which have good covering power the strong characteristic colors cannot be used as the foundation of any tints except those in which their own color predominates. A good white, therefore, is essential as the basis for tints. Unfortunately only two fairly good whites, and neither of them satisfactory, are known to exist. These are white lead and zinc white. Both of them are inferior in covering power, both of them very greatly lack in durability, and both of them are moderately expensive. The lack of durability of these two pigments manifests itself apparently in diametrically opposite ways. White lead crumbles and powders away apparently as the result of chemical action between the pigment and the oil, and is readily decomposed and blackened by sulphur gases in the air. Zinc white likewise apparently combines chemically with the oil, but instead of powdering peels off in flakes, and the action of sulphur gases if it takes place at all does not result in blackening, obviously because the sulphide of zinc is white. It is a very great misfortune that there is no white known which has greater covering power and greater durability than either zinc white or white lead, and although neither of them is satisfactory, there seems to be no alternative at present except to use them as best we can. Our experience in absolute durability of these pigments is not as great as we could wish, although we have experiments in progress. We are therefore not able to give as positive information as we could wish on the subject. We are inclined to mix the two pigments rather than to use either one alone, especially for outdoor work. The proper mixture of white lead and zinc white being decided on—and in our experiments we have used equal volumes of the two—to secure the tint that is desired, use such tinting materials as may be necessary. If a reddish yellow is desired a little ochre and a little oxide of iron will give the desired color. The brown tint is readily obtained by mixing red and black. The proportions and kinds of pigments to be used to secure the various colors are a part of the art of the manufacture, and do not enter into the discussion here further than to say that no materials should be used between which there is a possible chemical reaction in water solution—that is to say, if you put two pigments together in water and they mutually decompose each other these pigments should never be used in the same paint.

The various tinting materials to be used have different covering power. For example, if a fairly strong percentage of chrome yellow is used in securing the tint the covering power will be greatly improved; so also if any considerable amount of lamp-black or iron oxide is used the covering power will be greatly improved. In these cases it is always possible to use more or less inert material with, as we believe, increased durability and diminished cost in the paint. The law for tint, therefore, would seem to be as follows: Use a mixture of white lead and zinc white, possibly in equal quantities, as a basis. Add to this the necessary materials to produce the tint desired, and then add all that the material will bear of inert material—preferably, so far as our experience has gone, sulphate of lime.

The discussion in the foregoing article may perhaps be summed up as follows: In answer to the question, "What pigment shall be used?" we say, first, if there is any pigment not too expensive of the desired color use this pigment, and add to it as much inert material as it will bear without interfering seriously with the covering power; second, if there is no pigment of the desired color use a mixture of white lead and zinc white half and half by volume as the basis, add to this the necessary tinting materials, and then add as much inert material as the mixture will bear without interfering with the optical covering power; third, do not mix pigments which have any possible chemical reactions between themselves in water solution, and do not add to any pigment any inert material between which and the pigment there is any possible chemical reaction in water solution.

In the next article we will discuss what liquid shall be used and also the proportions of pigment and liquid.

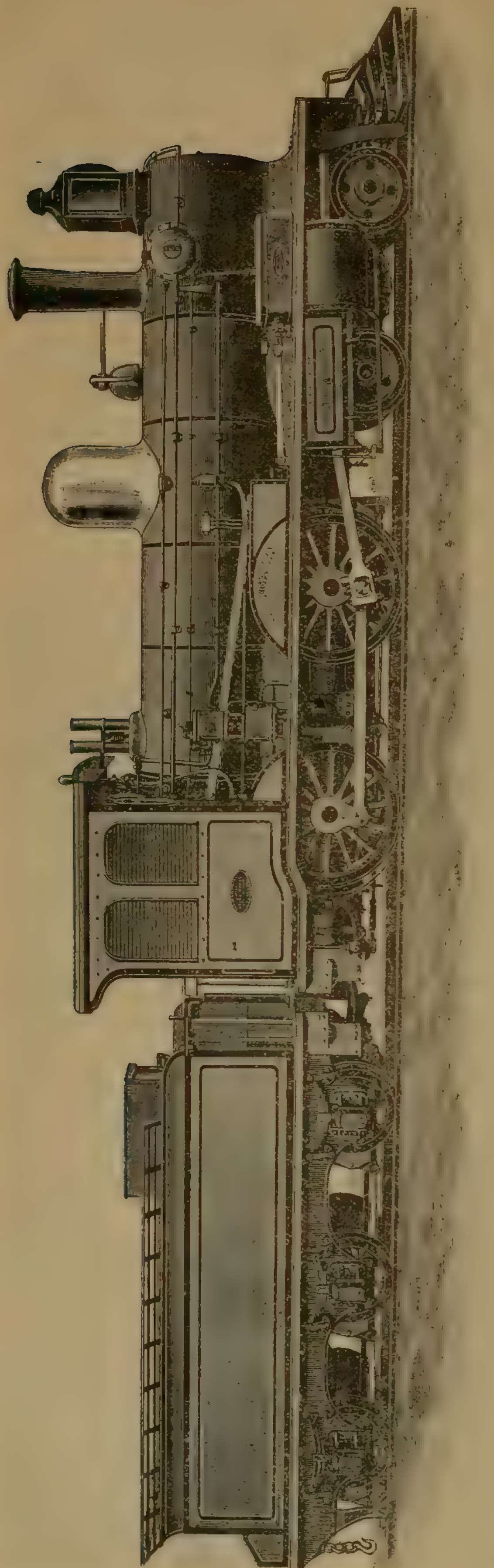
(TO BE CONTINUED.)

### Experiments on Train Resistance.

(M. Desdouits in *Proceedings* of the Institution of Civil Engineers.)

For several years many experiments have been made on the State Railroads of France to determine the motive power and resistance of trains, in order to settle the conditions on which the greatest economy of motive power may be effected. The trials were made with trains in service under ordinary conditions. The power developed in the locomotive was measured by means of the indicator for various speeds and various periods of admission. In one instance—of a passenger locomotive, having 17.3 in. cylinders, 26 in. stroke, with Allan's link motion—it was shown that, for all degrees of admission, the moving power increased as the speed increased, starting from low speeds, until the maximum power was developed at a speed of about 21¾ miles—35 kiloms.—per hour. For higher speeds, and for all degrees of admission, the power decreases very sensibly as the speed is increased. The maximum effective force attained with 70 per cent. of admission at a speed of 21¾ miles per hour is 11,000 lbs.—5,000 kilogs.—for which the "theoretical" effort is 12,480 lbs.—5660 kilogs. The difference is only 12 per cent., of which, allowing 3 per cent. for the loss of absolute effort due to wire-drawing and compression, there is a maximum of 9 per cent. absorbed by passive resistances. In engines having piston valves with Walschaerts' gear the passive resistances do not exceed 7 per cent. From the results of observation, taken together, it is established that the consumption of steam, including moisture, is less than 24.2 lbs.—11 litres—per effective horse-power in a passenger locomotive in good condition; with steam of 9 atmospheres, cutting off at 20 per cent. at moderate speed—31 miles an hour. The consumption of fuel of good quality is about 2.68 lbs. per horse-power. The author argues that the economy effected by the compounding of locomotives can hardly exceed 10 per cent.

From various data it is deduced that the effective work done per unit of steam, for all speeds, attains its maximum value when the steam is cut off at about 20 per cent. of the stroke. At low speeds an admission approaching 30 per cent. may be practised, or it may be a little less than 20 per cent.; but, for considerable speeds, an admission of from 20 to 25 per cent. is to be adhered to in order to attain maximum economy. A passenger engine attains maximum economy, traveling at a speed of from 25 to 30 miles per hour, cutting off at 20 per cent. At a speed of 37 miles per hour there is a loss of 10 per cent. of efficiency; at 43 miles per hour the loss exceeds 25 per cent. These results point to a want of harmony between the best speed for economy and the usual working speeds, and they suggest that an augmentation of the diameter of the wheels is desirable. But this expedient does not afford much scope, and it is more likely that the removal of inside lap, or the provision of inside clearance, would reduce, if not altogether prevent, the diminution of efficiency at the higher speeds. The total resistance of engines with their tenders, at low speeds of from 2½ to 5 miles an hour, varied from 6 94 lbs. to 10 64 lbs. per ton, using colza oil for lubricant; and from 5.82 lbs. to 9.63 lbs., using naphtha oil; having four-coupled, six-coupled, and eight-coupled wheels. The engine and tender weighed together 50 tons, ex-



COMPOUND PASSENGER LOCOMOTIVE, ARGENTINE GOVERNMENT RAILROADS.

cept in one instance 70 tons. The resistance of the mechanism alone varied from 1.87 lbs. to 3 lbs. per ton. Tenders alone have a resistance of from $5\frac{1}{4}$ lbs. to 6.2 lbs. per ton; the resistance of the engine alone is from 7 lbs. to 8.8 lbs. per ton.

The author directs attention to "an extremely important element of resistance"—the reaction of the surrounding atmosphere—the greater portion of which applies directly to the locomotive, the resistance of which, with high-speed trains, amounts frequently to more than half the total resistance. Two engines, of which the resistance was measured separately and found to be 19.8 lbs. per ton at 37 miles per hour, were coupled together and again tried. The resistance fell to 14.3 lbs. per ton; the second engine was masked by the first. It is argued that by a suitable adaptation to the front of the engine a saving of from 8 to 10 per cent. of the effective power could be made. The resistance of carriages and wagons, weighing, empty, 10 tons and $7\frac{1}{2}$ tons respectively, was found to be $3\frac{1}{2}$ lbs. per ton at low speeds. Further deductions are made from numerous experiments.

## AN ARGENTINE COMPOUND LOCOMOTIVE.

THE accompanying illustration, which is taken from the London *Railway Engineer*, represents one of 11 compound engines of the Worsdell-Von Borries system for the Argentine Government Railroads. The engines are for a railroad of one meter gauge, having minimum radii of curvature of 984 ft., and are built to burn wood. They are, as will be seen from the engraving, of the eight-wheel or American type, having a four-wheel truck forward and four driving-wheels.

The boiler, which is built to carry a working pressure of 175 lbs., is 46 in. in diameter of barrel and has 135 brass tubes 2 in. outside diameter and 10 ft. 6 in. in length. It has an extended smoke-box of a somewhat clumsy looking pattern and of unusual length, 4 ft. 9 in. outside. The fire-box, which is of copper, is 78 in. in length and $26\frac{1}{2}$ in. wide inside.

The high-pressure cylinder is 15 in. in diameter and the low-pressure cylinder $21\frac{1}{2}$ in., the ratio therefore being 1 : 2.06. The stroke is 22 in. The low-pressure cylinder has steam-ports $16\frac{1}{2} \times 1\frac{1}{2}$ in. and exhaust-ports $16\frac{1}{2} \times 2\frac{9}{16}$ in., the slide-valve having 1 in. outside lap. The high-pressure cylinder has steam-ports $11\frac{7}{8} \times 1\frac{3}{16}$ in. and exhaust-port $11\frac{1}{8} \times 2\frac{1}{4}$ in., the slide-valve having also 1 in. outside lap.

The driving-wheels are 54 in. in diameter and the truck-wheels 30 in. The center of the boiler is 5 ft. 9 in. above the rails. The frames are of the plate type, and are of $\frac{7}{8}$-in. steel. The driving axle journals are $6 \times 8$ in. and the truck axle journals $4\frac{3}{4} \times 9$ in. The total weight of these engines is 58,400 lbs. empty, of which 48,500 lbs. are carried on the drivers and 9,900 lbs. upon the truck. The weight in working order is about 70,000 lbs.

The tender is carried upon six wheels provided with radial axle boxes. Its weight, light, is about 19,000 lbs. The tender wheels are 33 in. in diameter. The capacity of the tank is about 2,100 gals. of water.

These engines were built by Sharpe, Stewart & Company in Glasgow, Scotland, and in addition to the 11 passenger engines the same company is building 27 freight engines, which are also eight-wheel compound engines, but are somewhat heavier than those intended for passenger service.

## THE ESSENTIALS OF MECHANICAL DRAWING.

BY M. N. FORNEY.



(*Continued from page* 134.)

### CHAPTER X.

#### SHADE AND SECTION LINES.

WHEN light falls on one side of an object, as every one knows, the side nearest to the light is illuminated and that farthest from it is in shadow. To indicate this effect in outline drawings, it is customary to make the lines on the shaded side of objects heavier than those on the illuminated sides, which *suggests*, although it does not correctly represent, the effect of light as we see it in nature.

In drawing such *shade lines*, as they are called, the light, for the sake of explicitness, is always supposed to fall upon the object in parallel lines, as explained in Chapter IV, and to produce the maximum effect on the shaded vertical and hori-

zontal lines and surfaces of the objects represented, the light is supposed to fall obliquely from the upper left-hand corner of the sheet of paper toward the lower right-hand corner at an angle of 45° to the vertical and horizontal lines of the drawing.

Fig. 226.

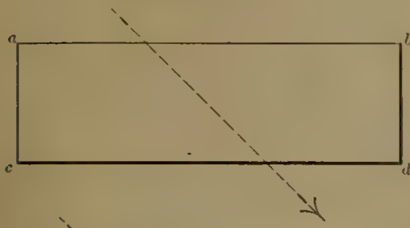
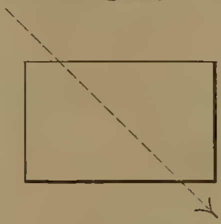
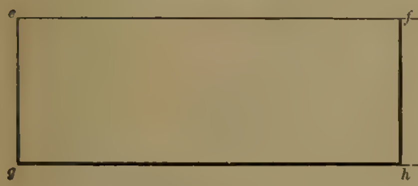



Fig. 227.



Scale 3 in.=1 ft.

Fig. 228.



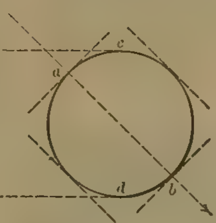




Fig. 229. Fig. 230.

exposed to the light, and *b d* and *d c* are shaded. Consequently the first two are represented by light lines and the latter by dark or heavy lines. The sides in the end elevation, fig. 227, and the plan, fig. 228, are similarly drawn.

Fig. 229 represents a side view of a cylindrical-shaped object, and fig. 230 an end elevation of it. In the latter view the light is again supposed to fall in the direction of 45° to vertical and horizontal lines, as indicated by the dotted dart. At *a*, in the end view, the surface of the cylinder is at right angles to the dart, and therefore this is the point of greatest illumination, or the *highest light*, as it is called. At *b* the surface is again at right angles to the direction in which the light falls, but it is opposite to the light, and for this reason is in the darkest shade. As the angle which the surface of the cylinder bears to the direction in which the light falls increases from *a* to *b* on both sides, the outline in this view should be lightest at *a* and darkest at *b*, and should gradually increase in darkness from *a* to *b* on both sides of the cylinder.

To draw the outline of the end view, a very light circle should first be drawn, being careful in doing this to make as small a prick mark for a center with the compasses as possible. If the circle is of considerable size, say an inch or more in diameter, it is best to take another center slightly nearer to *b* than the original center was. Then draw part of another fine circle on the shaded side from the new center. This second circle will be slightly eccentric to the first one. The space between the two circles may then be filled with ink by gradually increasing the distance between the points or nibs of the compass pen. Some skill is required to do this neatly, and the student will probably fail in doing it at first; but a little practise will teach him the required "knack."

If the circle is smaller than an inch in diameter, its circumference may be drawn heavier on one side than the other by pressing gently with a finger of the left hand against the point of the compasses, thus pushing it slightly in the center prick mark toward the shaded side of the object. Some skill is also required to do this neatly, but it is easily acquired with a little practise.

In fig. 229 the lines *e f* and *g h* represent the surfaces of the cylinder shown at *c* and *d* in fig. 230. It will be noticed that the outline at *c* is only slightly heavier than it is at the most highly illuminated point at *a*. Consequently *e f* should be drawn only a *very little* heavier than a line which

Fig. 235.


Fig. 236.

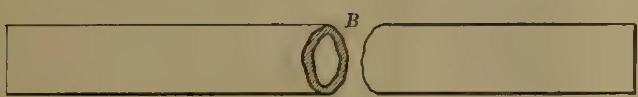



Fig. 237.

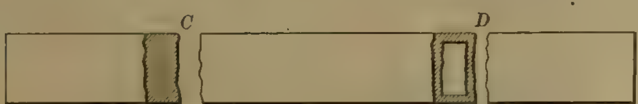



Fig. 238.

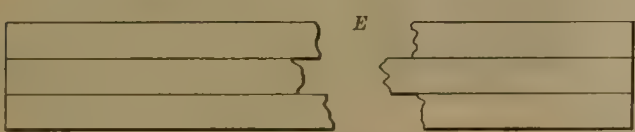



Fig. 239.


Fig. 231.

Fig. 232.

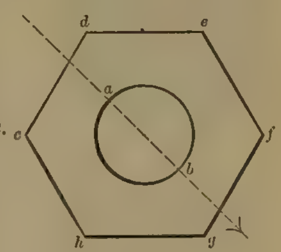



Fig. 233.

Fig. 234.

All the parts may therefore be shaded according to one uniform rule. Thus, in figs. 226, 227 and 228, which are side and end views and a plan respectively of an ordinary brick, the light is supposed to fall in the direction of the dotted darts. It is plain that when this occurs, that the sides *a b* and *a c*, in fig. 226, are

would represent the most highly illuminated part of the cylinder. At *d* the outline is very nearly, but not quite, as heavy as at *b*, where the surface of the cylinder is in the deepest shade. Therefore the line *g h* should be drawn as heavy as the circumference of the circle is represented at *d*, in fig. 230.

It must be admitted, however, that this proportioning of lines is a refinement that is seldom observed in practical work. In some books on mechanical drawing, it is held that lines, like *e f* and *g h*, which represent surfaces, as *c* and *g seen edgewise*—and not *intersections of surfaces*, as the outlines of the brick in figs. 226–228 do—should never be represented by heavy lines. The reasoning in support of this opinion does not seem to have enough force to sustain the practise.

Figs. 231 and 232 represent an ordinary hexagonal blank nut—that is, a nut without the thread cut in it. From the plan, fig. 232, it will be seen that the side of the hole at *a* is in the deepest shade, and at *b* it is in the highest light. The circle representing the hole should therefore be heaviest at *a* and lightest at *b*, and it should be drawn in the same way as the one shown in fig. 230.

It will also be seen that the side *c d*, in fig. 232, is exposed to the strongest light, *d e* is illuminated less, and *c h* still less, and *h g*, *g f* and *e f* are in shadow. The width of the lines representing these sides should be proportioned to their illumination. The same rule applies to the vertical lines representing the intersection of the sides in fig. 231. Every shade line should be of a thickness regulated by its being more or less from the light side, as shown in figs. 229–232 and in figs. 233 and 234.

SYMBOLICAL SHADING AND COLORS.

*For Cross Sections of Different Materials.*

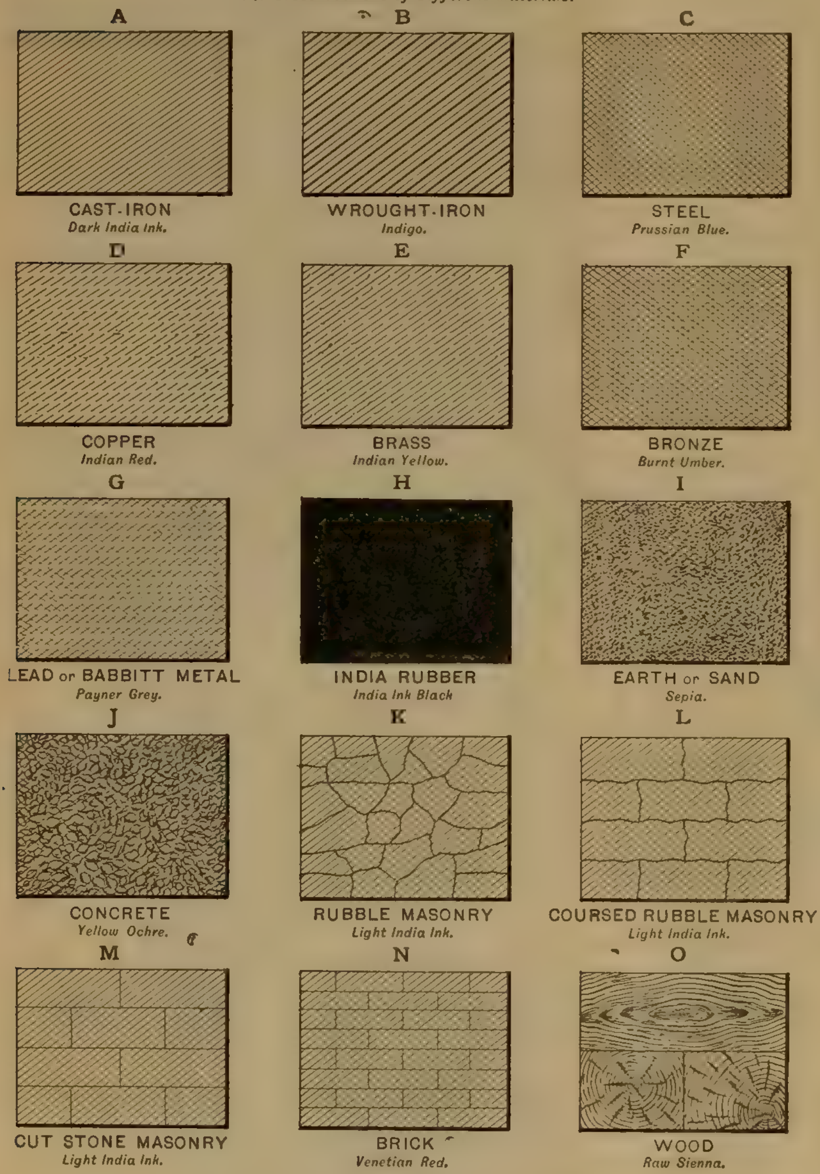



Fig. 240.

As* explained in Chapter V, in representing any objects, such as shafting, which are too long to admit of being shown full length to the scale on which the drawing is made, the ordinary way is to show it as if broken off. The break can be made in the middle of the length, as shown at *A*, fig. 235, or at any other convenient place, depending on its surroundings. If it is a round shaft, it is better to show the section of an elliptical form, to indicate the shape of the shaft, and more especially so if the drawing is only in outline. Similarly the form of a pipe, square bar, or other object, may be indicated at the point where the break is represented, as at *B C* and *D*, figs. 236 and 237. While this gives a more elegant appearance to a drawing, it is often disregarded in practical work to save time.

When two or more pieces in contact are shown, as in fig. 238, the break at the ends should be such as to show each piece distinct from the one adjoining it; and in showing a portion of iron plates, as in figs. 157 to 160, where two or three are joined together, the distinction of each plate at the ends should be clear. When the full length of any object is not to be shown, it is better to represent it broken off than squared off, as the latter course will indicate the termination of its length.

When two pieces are shown in section and in contact with each other, as *F G* and *H* in fig. 239, the section lines should be inclined in reverse direction to each other. If three pieces, as *F G I*, are in contact in such a way that one of them, *I*, touches the other two, its section lines should be drawn at a different angle to those of the other two pieces. In fig. 239 the lines of *F G* and *H* are drawn at angles of 60° to a vertical line, whereas the lines in *I* and *J* are represented at angles of 30° to a perpendicular. This, it will be seen, makes a little distinction between the surfaces of *F* and *I* and of *G* and *J*, which are inclined in the same direction, but at different angles.

In order to show the materials of which the different parts of a structure are made, conventional methods of drawing shade lines and combinations of different kinds of lines are used. Unfortunately there is no uniformity and little agreement on the kinds of shading, or "*hatching*," as it is called, which is used for this purpose, and no standard has been recommended by any authority with sufficient influence to secure its general adoption. Fig. 240 shows symbolical methods of representing sections of different materials, which have been collated from different authorities or devised by the author for this purpose. Thus a section if shaded, as shown at *A*, is intended to represent cast iron. As this material is represented in section in drawings of machinery more frequently than any other, the simplest method of shading has been selected to symbolize it. Wrought iron is indicated at *B* and with similar lines, excepting that every alternate line is heavier than those which adjoin it. No other explanation is needed to make the uses of the other surfaces, shown in fig. 240, clear to the reader.

As drawings are sometimes colored to show the materials of which the parts are made, the names of the colors to be used in representing the different materials indicated in fig. 240 are also given. In selecting these simple colors and not mixtures have been chosen. When combinations of tints are used it is difficult to get them alike at different times. Further directions with reference to the method of applying and using colors will be given in a future chapter. It may be mentioned, however, that they are not employed in making mechanical drawings as much as they were formerly. The fact that they cannot be copied in the process of blue printing—which will be described hereafter—and in photo-engraving has lessened their use very much of late years. It may also be

* Much of this and the following paragraph is quoted from "The Workman's Manual of Engineering Drawing," by John Maxton.

mentioned that more importance has been assigned by writers on the use of symbolical methods of shading and coloring sections than the subject seems to deserve. Usually there is no uncertainty concerning the materials of which the different parts of a machine or other structure represented in a drawing are made. If there is, it is always best to designate by writing on the drawing the material to be used.

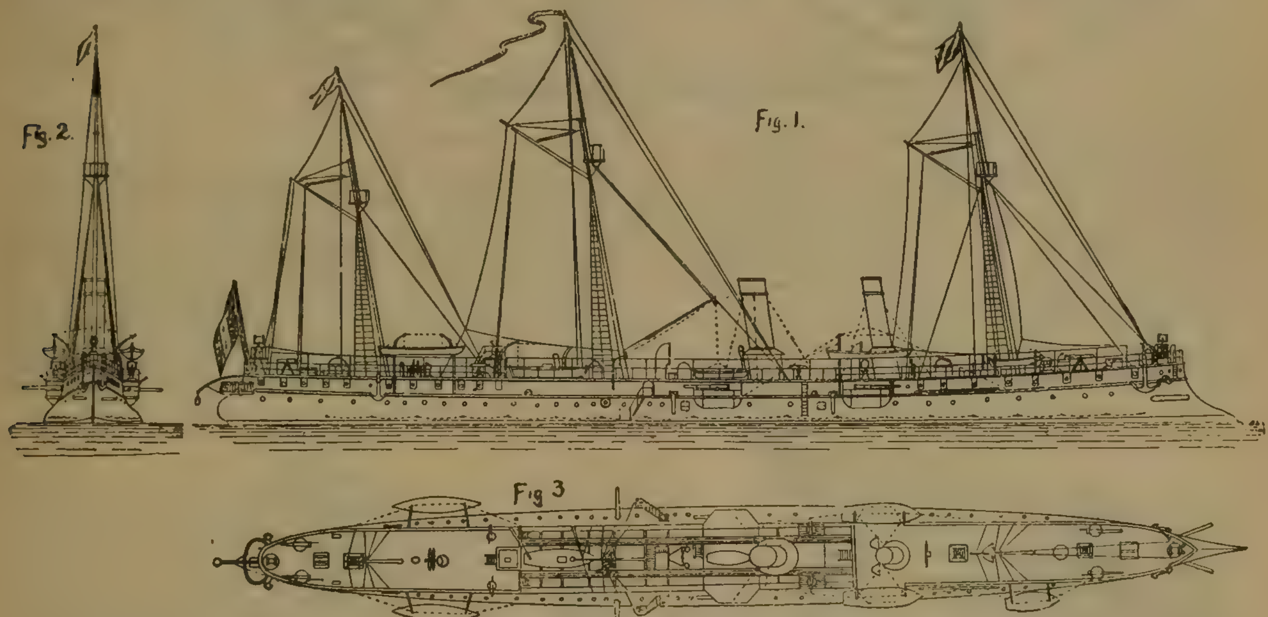
(TO BE CONTINUED.)

## Foreign Naval Notes.

### AN AUSTRIAN CRUISER.

Two new protected cruisers are now under construction for the Austrian Navy at Pola. The first of these, the *Kaiserin Elizabeth*, was recently launched ; her principal dimensions are : Length, 339 ft.; breadth, 40 ft. 6 in.; mean draft, 18 ft.; displacement, 4,060 tons.

The main battery will consist of two 9-in. guns mounted in barbettes, one forward and one aft, and six 6-in. guns. The secondary battery will include two $2\frac{3}{4}$-in. Uchatius guns, eleven rapid-fire guns, and six torpedo-tubes.




THIRD-CLASS CRUISER "LE TROUDE," FOR THE FRENCH NAVY.

The engines are to work up to 6,400 H. P. with natural draft, giving a speed of $17\frac{1}{2}$ knots ; and to 9,800 H. P., with forced draft, giving a speed of 19 knots. The capacity of the coal-bunkers is 570 tons, giving a radius of action, at full speed with natural draft, of 4,500 knots.

### A NEW FRENCH BATTLE-SHIP.

The plans prepared for the new French battle-ship *Jaureguiberry* have been approved by the Ministry of Marine, and work will be begun at once on the ship. The designs were made by Chief Engineer Lagane, and the ship will be built at La Seyne. The principal dimensions are : Length, 108.50 m. (355.8 ft.) ; breadth, 22.15 m. (72.65 ft.) ; depth, 14.63 m. (47.98 ft.) ; draft of water aft, 8.45 m. (27.71 ft.) ; displacement, 11,818 tons. The engines are to work up to 13,275 H.P. with natural draft, and to give the ship a speed of 17 knots an hour.

The ship will have a belt of water-line armor varying from 275 to 450 mm. (10.82 in. to 17.71 in.) in thickness, and will be further protected by an armored deck 70 mm. (2.75 in.) thick, and by a cofferdam filled with celluloid and backed by a plate 100 mm. (3.93 in.) thick. There will be four turrets protected by plates 370 mm. (14.56 in.) thick, placed in a square, and each carrying a large gun ; also four smaller turrets 100 mm. (3.93 in.) thick and each carrying two smaller guns.

The main battery will consist of two 30-cm. (11.81-in.), two 27-cm. (10.62-in.), and eight 14-cm. (5.51-in). guns, and the secondary battery of four 65 mm. (2.55-in.) and twelve 47-mm. (1.85-in.) rapid-fire guns ; eight 37-mm. (1.45-in.) revolving cannon, and six torpedo tubes.

A special feature of this ship will be the employment of electricity, not only for lighting, but for running the motors which operate the turrets, hoist the ammunition and assist in loading the guns. The application of the electric motor will be more extensive than in any French ship yet built.

Another peculiarity will be that the steam power will be furnished by tubulous boilers. The ship will have 24 d'Allest boilers, which will carry a working pressure of 210 tons. This boiler was described in the JOURNAL for November, 1890, page 498.

### A CHILIAN CRUISER.

The armored cruiser, *Capitan Prat*, built for the Chilian Government by the Compagnie des Forges et Chantiers, at La Seyne, France, was recently launched there. The chief dimensions of this ship are : Length, 328 ft.; breadth, 60 ft.; mean draft, 25 ft.; displacement, 6,900 tons. Her engines are expected to work up to 8,000 H.P., and to give the ship a speed of 17 knots with natural draft, and 19 knots with forced draft.

The armor protection consists of a water-line belt, a central barbette covering the engines, and turret shields for the large guns, with shield protection for the smaller ones.

The armament includes four 24-cm. (9.45-in.) Canet guns in turrets ; eight 12-cm. (4.72-in.) Canet rapid-fire guns ; four 57-mm. (2.24-in.), and four 47-mm. (1.85-in.) Hotchkiss guns ; six 37-mm. (1.46-in.) revolving cannon ; five 11-mm. (0.43-in.) Maxim guns, and four Canet torpedo tubes. The guns are all provided with electrical apparatus for firing, and electric motors are provided for hoisting the ammunition and working the turrets. The arrangement of the guns is such that the fire of three 24-cm. and four 12-cm. guns can be concentrated on any point.

### A FRENCH LIGHT CRUISER.

The accompanying illustration, from *Le Yacht*, shows the new cruiser, *Le Troude*, built for the French Navy by the Société des Chantiers et Ateliers, at Bordeaux. On the trials this ship made the following record : In two hours' steaming under forced draft, the engines showed 6,247 H.P., and the ship a speed of 20.9 knots an hour ; in a 12 hours' trip at full speed, with natural draft, 3,393 H.P., and an average of 17.6 knots ; in a six hours' trip at cruising speed, 1,591 H.P., and an average of 14.2 knots. Fig. 1 is a side-view ; fig. 2 a front view and fig. 3 a deck plan.

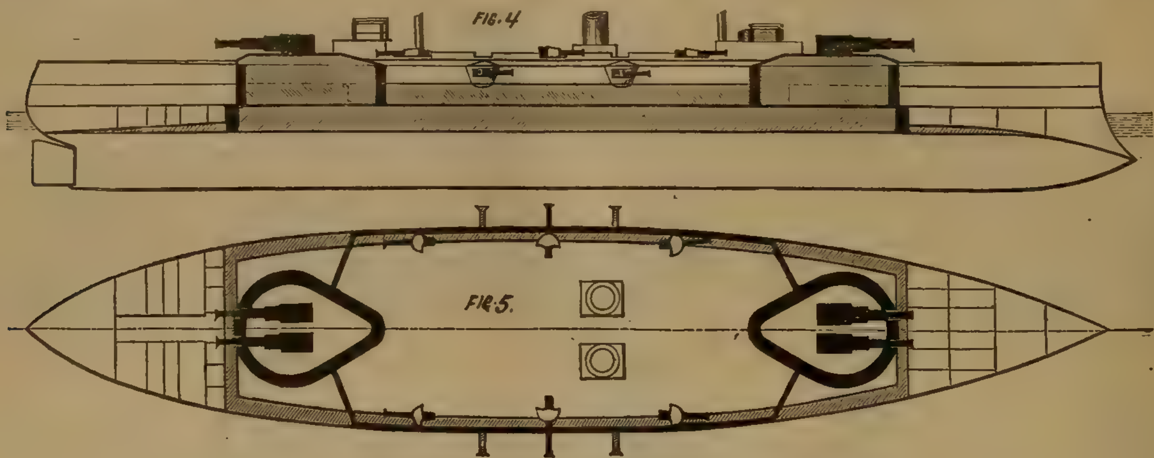
*Le Troude* is a cruiser of the third class, 312 ft. long, 31.16 ft. extreme breadth, 14.1 ft. mean draft and 1,880 tons displacement. Her armament is light, consisting of four 14-cm. (5.5-in.) guns, four 47-mm. (1.85-in.) rapid-fire guns, four 37-mm. (1.46-in.) revolving cannon and four torpedo-tubes.

There are two screws, each 13.4 ft. in diameter and 16.6 ft. pitch. Each screw is driven by a compound engine having cylinders 37 in. and 74 in. in diameter and 36 in. stroke. The steam is furnished by five cylindrical boilers, each 10 ft. 2 in. in diameter and 19 ft. long, and having three fire-boxes. The working pressure is 100 lbs. usually.

### TWO NEW ENGLISH WAR-SHIPS.

Two large ships for the English Navy were launched at Portsmouth, February 26. The first, the *Royal Arthur*, is a twin-screw steel cruiser 360 ft. long, 60 ft. wide, and 7,350 tons displacement. She has a protective or armor deck of steel extending from stem to stern, but no vertical armor protection. This deck springs from the ship's sides at a point 3 ft. to 4 ft. below the water-line and slopes upward until reaching a point above the water-line. It is in the middle part (in an athwart-ship direction), practically flat. This form is that adopted in the midship part of the vessel; at the ends the deck is practically flat. The maximum thickness is 5 in. on the slopes and 2½ in. on the horizontal part. The coal bunkers are arranged to give protection above and below the water-line.

The engines are designed to give out 12,000 indicated H.P. with forced draft and 7,500 H.P. with natural draft, the respective calculated speeds being 20 and 18 knots per hour. The armament will consist of two 9.2-in. guns and twelve 6-in. guns, and a number of small rapid-fire guns. The coal endurance will be 10 000 knots at ten-knot speed.




ENGLISH BATTLE-SHIP "ROYAL SOVEREIGN."

The *Royal Sovereign* is the largest battle-ship yet built; the general arrangement of guns and armor is shown on the accompanying diagram, figs. 4 and 5. She carries her heavy armament en barbette, and is propelled by twin screws. The length is 380 ft., the breadth 75 ft., and the displacement is calculated at 14,150 tons. The engines are designed to exert about 9,000 indicated H.P. with natural draft, and the corresponding speed will be about 16 knots per hour. With forced draft the horse-power is put down at 13,000 indicated, and the corresponding speed is estimated at 17½ knots. The estimated speeds, it should be stated, are those with the ship fully laden. The "radius of action," or "coal endurance," at speed of 10 knots, is to be 5,000 knots; at a speed of 16 knots, 1,800 knots.

The armament will be as follows: Four 13½-in., 67-ton guns on the summit of the barbette; ten 6-in. guns in broadside; 24 small rapid-fire guns, and seven torpedo-tubes.

The ship will have a belt of armor with steel face and iron back on the compound system. This will have a maximum thickness of 18 in., and will be 8½ ft. deep, 3 ft. being above and 5½ ft. below the load water-line. The ends of the port and starboard sides of the belt will be joined by athwart-ship armored bulkheads of 14 in. thickness. The top edges of the port and starboard belt will be joined by a flat horizontal steel deck 3 in. thick.

At this point the ship may be likened to a shallow box or tray of armor placed bottom up, the sides dipping below the water-level and the inverted bottom consisting of the steel deck. Beyond the ends of the citadel so formed the vessel is not protected by vertical armor at all, the only protection being a 3-in. steel deck wrought below the water-line. Above the citadel already described, and at the extreme ends, are placed the two barbettes. These are pear-shaped structures heavily armored vertically, but having no armored top or horizontal component. In each barbette is placed, side by side, a pair of 67-ton guns, two pointing forward and two aft, but both, of course, having an extensive arc of fire on either broadside. The guns are carried in the open, above the barbette, pointing over the top of the structure.

The armor protection of the *Royal Sovereign* is completed by a more lightly-armored citadel covering that part of the ship between the two barbettes—overlapping them to some extent—and above the 3-in. deck already mentioned. The armor line is of steel and 5 in. thick. It rises to a height of 9½ ft. above water, and it covers 145 ft. of each side. It is in and upon this structure that the secondary armament will be placed, there being two sponson ports on each side, while the guns mounted above are protected by armored shields.

Fig. 6.

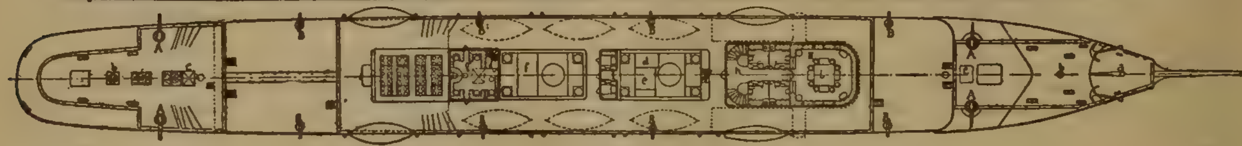


Fig. 7.

AUXILIARY OR RESERVE CRUISER "EMPRESS OF INDIA."

### AN ENGLISH AUXILIARY CRUISER.

The accompanying illustration gives a longitudinal section and deck plan of the *Empress of India*, a new ship just completed by the Naval Construction & Armament Company, at Barrow-in-Furness, England, for the Canadian Pacific Company, and intended for the line between Vancouver and Hong Kong. This ship, although built for passenger and freight service, is built under conditions imposed by the English Admiralty, fitting it for service as a cruiser in case of war. The principal dimensions of the ship are: Length, 485 ft. over all; breadth, 51 ft.; mean draft, 24 ft. 6 in. The ship is built on the double-bottom system and is divided into numerous water-tight compartments. It has full accommodation for a large number of passengers, and is provided with an electric light plant and other improvements. It is propelled by twin screws driven by triple-expansion engines, which on the trial trip developed a total of 9,720 H.P., giving the ship a speed of 18.5 knots an hour. With 7,725 H.P., a speed of 16.67 knots was reached. In ordinary service the speed is expected to be 15 knots an hour, which will enable the ship to make a trip from Vancouver to Yokohama in 12 days and 18 hours.

The ship is provided with all necessary fittings and arrangements to carry a number of 4-in. guns, and as a cruiser could be made into quite a formidable ship. Under the contract it is subject to be taken by the Admiralty at any time at a fixed payment. There are two sister ships—the *Empress of China* and the *Empress of Japan*—under construction at Barrow for the same line. The Company will receive a postal contract from the English Government, and has also a subsidy from the Canadian Government for the line.

In the accompanying illustrations, the letters *A* show the position for the 4-in. guns; *B*, rapid fire guns; *C*, sailors' quarters; *D*, magazine; *E*, freight; *F*, fire-room; *G*, refrigerator-room; *H*, freight; *I*, coal-bunker; *K*, first-class cabin; *L*, dining-room; *M*, baggage-room; *N*, saloon; *O*, captain's cabin; *P*, chart-room; *Q*, steering apparatus; *R*, second-class cabin; *S*, mail-room; *T* and *U*, store-rooms; *V*, ship stores; *W*, water-tank; *X* carpenters' room; *Y* sail-room; *Z* anchor chains. The loading crane and capstan are shown at *a* and *b*; the donkey engine at *c*; the condenser and tank at *d e* and the auxiliary boiler at *f*. The position of the engines and boilers is also given on the diagram.

## Recent Patents.

### DODGE'S MACHINERY FOR HANDLING COAL.

THE appliances shown in fig. 4 are the invention of Mr. J. M. Dodge, of Philadelphia. The engraving shows the intent of the invention, the operation of which is described as follows in the specification:

"*M* and *M'* are masonry supports for the lower ends of a pair of trusses inclined in opposite directions at or about the angle of repose of the pile and connected at their upper or


DODGE'S COAL-HANDLING MACHINERY.

meeting ends, so as to constitute the legs of a sheers structure, and *R* the rod or other connection between the feet of the sheers to prevent further spread. Suitable lateral guys are provided to stay the sheers in an upright position.

"The operation will be largely understood from the above description and a reference to the drawings. In the present instance the material is fed to the horizontal portion at any convenient point between $W^3$ and $W^4$, and after it leaves the level at $W^3$ it is carried up by the lower run of the conveyer and discharged onto the pile at its various stages of formation."

The number of the patent is 446,814.

### APPLEYARD'S SAFETY DEVICE FOR STREET-CARS.

Little description is needed of the "device" illustrated by the engraving herewith, which is the invention of Mr. A. E. Appleyard, of Boston. As shown by the illustration, he provides a kind of receptacle or basket in front of the car "to receive the body of an individual or animal that may be caught on the track by the car." This receptacle is composed of a strong frame hinged to the car-body at *b*, the front end being supported on small wheels 8, 8, which run on the track. The frame, as shown, is provided with a strong netting made of twine or rope, so that it may be said that this invention is intended to "rope in" trespassers on the track. A sort of sub-


APPLEYARD'S SAFETY DEVICE FOR STREET-CARS.

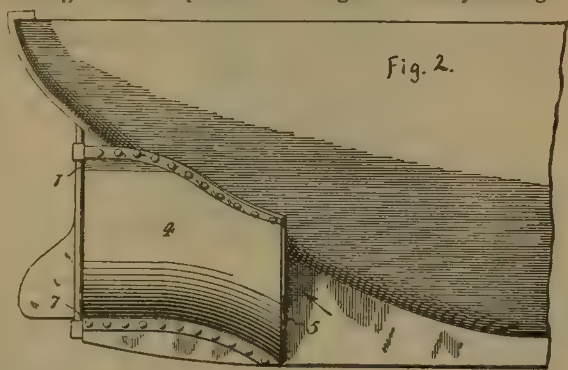
sidiary fender *h* is also provided to catch those who escape the net. The number of the patent is 443,738.

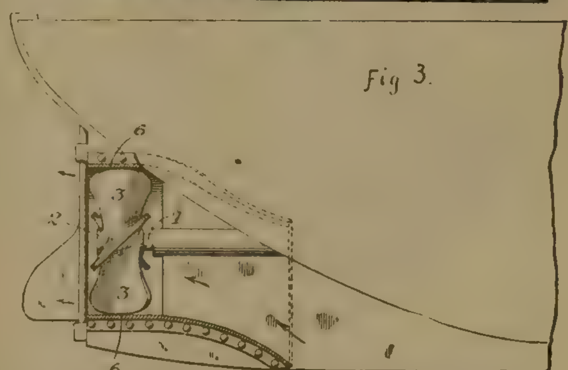
### DOCK'S MARINE PROPELLER.

Figs. 2 and 3 are views of the stern of a vessel with this "improvement" applied to it. In fig. 3 the casing around the propeller is shown in section. The inventor describes his improvement as follows:

"4 is a casing surrounding the propeller, made flaring at the forward end 5, and by easy curves converging to a cylindric form of the diameter of the propeller-blades, which fit and turn in it, but without contact or friction.

"The water is directed toward the propeller-blades by the guides 4, so that it passes at its highest velocity through the



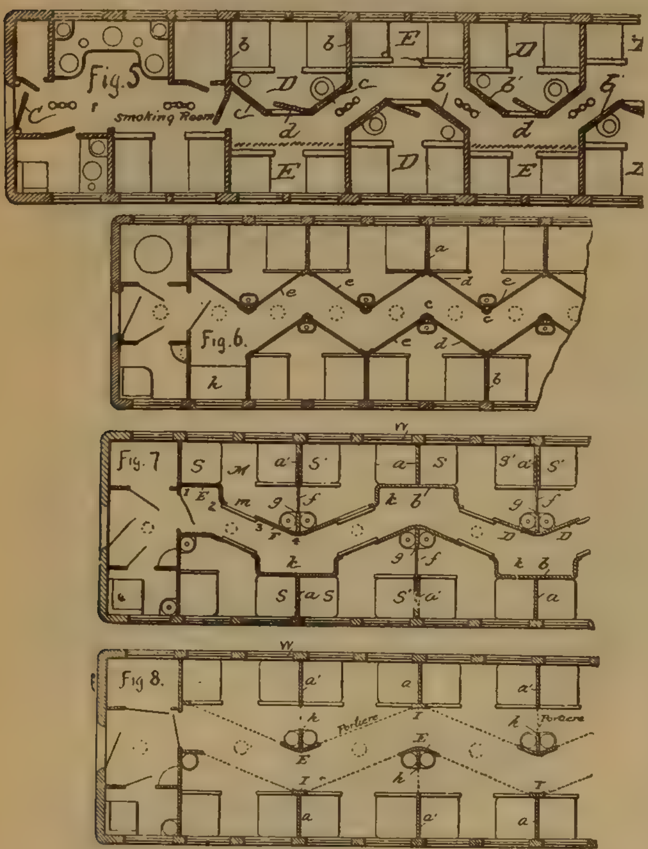

DOCK'S MARINE PROPELLER.

throat 6 of the guide, where the propeller engages it, and thus is prevented from diverging or spreading away from the propeller 3, and is delivered with the fullest effect in a solid stream from the after end 7 of the guide 4, and since the inertia of the fluid is most effectively operative when opposed to bodies moving at highest velocities, the support afforded by the water as a nut for the screw 3 to act upon being at the place of greatest velocity, it has the least slip possible, and the propelling effect is proportionably improved."

Probably some readers will be disposed to add an interrogation mark after the last paragraph. The inventor is Mr. Herman Dock, of Philadelphia. The number of the patent is 442,614.

ALLEN'S SLEEPING-CAR.

Figs. 5, 6, 7, and 8 represent plans of improvements for sleeping-cars that have recently been patented by Mr. E. G. Allen, of New Haven, Conn. Fig. 5 represents a plan of a portion of a car showing the improved compartments *D D* with suffi-



ALLEN'S SLEEPING-CAR.

cient space to allow the occupants to dress in privacy, and provided with a wash-bowl and other toilet articles. This is accomplished by extending the paneled section *c* diagonally toward the center of the car, and connecting the ends to a central section *d* which contains a door-frame and door. Between the sections *D D* are smaller ones *E E* protected with curtains in the usual way and intended for the accommodation of single persons. The aisle, it will be seen, has a zigzag form.

Fig. 6 shows another plan in which all the sections are provided with room to dress in and furnished with toilet appliances. Figs. 7 and 8 are other plans, fig. 7 showing an arrangement of sections enclosed with partitions and doors, and fig. 8 one in which curtains only are used.

The numbers of the patents are 440,295, 445,870, and 446,315.

# Manufactures.

## General Notes.

THE new works of the Newport News Ship Building & Dry-Dock Company cover 60 acres of land, having a water front on deep water of 1,825 ft. The buildings already erected cover 5 acres, and include office, boiler, blacksmith and machine-shops, wood-working shop, storage sheds, power-house and a number of others. On the water front there are four piers respectively 60 × 900, 60 × 350, 80 × 350, and 60 × 550 ft. in size, and an outfitting basin 900 × 500 ft. There are in the yard 8 ship-ways, two being 420 ft., two 450 ft. and four 500 ft. each, so that 8 vessels of the largest size can be under construction at once. The dry dock is of timber of the Simpson pattern, similar to that at the Norfolk Navy-Yard, its dimensions being: Length, 600 ft.; width on top, 130 ft.; width on bottom, 50 ft.; width at entrance, 93 ft.; draft of water over gate sill, 25 ft. A marine railroad capable of hauling out a ship of 2,000 tons is under construction. The shops are fitted with machinery of the latest pattern, and are supplied with hydraulic traveling cranes of 40 tons capacity, so that the largest work can be handled without difficulty. There is one derrick, with a lifting capacity of 130 tons, besides many smaller derricks distributed through the shops.

THE Schenectady Locomotive Works are building a Forney locomotive with 17 × 24 in. cylinders for the Erie & Wyoming Valley Railroad; it will burn anthracite coal.

THE iron filling and finishing paint made by Felton, Rau & Sibley, Philadelphia, has been approved and adopted by a number of leading manufacturers, and its use is rapidly increasing.

ON February 23 last, as a train on the Baltimore & Ohio Southwestern was side-tracked to let another pass, at Remington, O., the second train came around the curve, before the other train had got clear of the main track, at such speed that it was impossible to stop it, and scraped the side of the third car of the side-tracking train for about 12 ft., catching the fourth car under the corner, turned it over on its side into the ditch, injured several passengers and the conductor. This car was equipped with the Consolidated Car-Heating Company's fire-proof heater, which was located in the corner struck by the engine. Though the heater was somewhat loosened from its fastenings, lifted and tipped, it was but slightly broken, and notwithstanding a brisk fire was burning in it, no conflagration took place. Had the car been equipped with an ordinary heater, the trainmen say nothing could have prevented the car from taking fire.

THE Southern Pacific shops, in Sacramento, Cal., have just completed a compound locomotive, which is rebuilt from a simple engine made at the Schenectady Works some years ago. This engine is of the 12-wheel type, having eight 51-in. drivers and a four-wheel truck. The boiler is 60 in. in diameter; the grate area is 30 sq. ft. and the total heating surface 1,884 sq. ft. The engine is of the two-cylinder type, with a Pitkin intercepting valve placed between the high and low-pressure cylinders. The cylinders are 20 × 26 in. and 29 × 26 in. the ratio being 1 : 2.1. It will be used on the mountain grades over the Tehachepi Pass.

THE American Steel Car-Wheel Company, South Boston, Mass., is making car-wheels cast from Bessemer steel. These wheels are in use on a number of railroads, where they will receive a thorough trial.

THE Rhode Island Locomotive Works, in Providence, have recently delivered to the Union Pacific six 10-wheel engines, with 19 × 24-in. cylinders and 62-in. driving-wheels; these engines have boilers 64 in. diameter of barrel and Belpaire fire-boxes. Other recent deliveries include two 10-wheel engines, with 18 × 24-in. cylinders and 54-in. drivers to the Boston & Maine, and two eight-wheel engines of meter gauge to a railroad in South America. The latter have boilers 46 in. in diameter of barrel, 15 × 20-in. cylinders and 48-in. drivers.

THE Joseph Dixon Crucible Company has begun the building of an addition to its works in the form of a three-story building 25 × 100 ft. in size, which will be used principally for office purposes. The present offices will be added to the factory, together with a new building four stories high and 100 × 100 ft. in size. The new building will contain large additions to the manufacturing plant, which will increase the capacity of the works.

THE Brown & Sharpe Manufacturing Company, Providence, R. I., is erecting a new four-story brick building, 100 ft. long and 56 ft. wide. The construction is similar to that of the main machine-shop buildings, and is practically fire-proof throughout. The walls are 20 in. thick, and have two ventilating flues 6 × 8 in. in each pier. A large proportion of the wall space is occupied by windows. The floors and roofs rest on iron beams, supported by three transverse rows of iron columns 16 ft. apart. The heavier beams are in pairs and are 20 in. deep; the lighter are 15 in. deep. The latter are 8 ft. from center to center, and support brick arches 4 in. thick, 10 in. rise. The floors are 5 in. thick. The first layer from beam to beam is 2¾ in. splined spruce plank. The second layer is 1⅛ in. spruce laid diagonally with the plank, and the third, or top layer, is 1⅛ in. hard pine laid parallel with the 3 in. plank. The roof is solid concrete covered with tar and gravel. The stairways are iron. Benches are the stand-

ard pattern, and sanitary closets will be used. The building will be devoted to the manufacture of a variety of small tools and instruments for accurate measurements.

THE Lunkenheimer Brass Manufacturing Company, Cincinnati, O., has purchased the entire plant and business of the Porteous Brass Company of the same place, and has removed the machinery and tools of the latter Company to a new addition recently constructed to its own works, the capacity of which is thus largely increased.

THE Sewall steam coupler, manufactured by the Consolidated Car-Heating Company, Albany, is now in use on railroads covering a mileage of 37,562 miles and using 7,080 passenger cars. This includes such lines as the Boston & Maine; the Chicago & Northwestern; the Grand Trunk; the Louisville & Nashville; the Richmond & Danville, and many other important lines. The McElroy coupler, also manufactured by the Consolidated Car-Heating Company, is in use on railroads having a mileage of 8,188 miles and 2,557 passenger cars. The system of the Consolidated Company has recently been specially commended by the Railroad Commissioners of Maine.

THE Baldwin Locomotive Works, Philadelphia, are building 13 Forney locomotives for the Manhattan Elevated Railroad in New York. The boilers are 42 in. diameter of barrel; the fire-boxes are of the Belpaire type, which is in use on a number of the Manhattan engines. The grate area is 16 sq. ft.; the total heating surface 430 sq. ft. The cylinders are 12 × 16 in.; driving-wheels 42 in. and truck-wheels 26 in. in diameter. The fixed wheel-base is 5 ft.; total wheel-base, 16 ft. The total weight is 47,000 lbs. in working order.

THE Armington & Sims Engine Company, Providence, R. I., has recently added to the works a new machine-shop, and a steam laboratory and testing room, completely fitted up. This company has recently completed a compound engine of 1,000 H.P., to drive a train of rolls in the mill of the Washburn & Moen Company at Worcester, Mass. This engine will be run from 250 to 300 revolutions per minute.

THE first vessel built at the yard of the Chicago Ship Building Company, Chicago, was launched March 14. This ship, the *Marina*, has been built for the Minnesota Steamship Company, and is the first steel steamer ever built on Lake Michigan. She is 308 ft. long over all, 40 ft. beam, and 24 ft. 6 in. deep. The engines are of the triple-expansion type, with cylinders 24 in., 38 in., and 61 in. in diameter and 42 in. stroke. The steam is furnished by two steel Scotch boilers, each 14 ft. in diameter and 12 ft. 6 in. long.

RECENT sales by Riehle Brothers, in Philadelphia, include a 200,000-lbs. testing machine to Cornell University; 50,000-lbs. testing machines to the Baltimore & Ohio Railroad, to Paige, Carey & Company, Wheeling, W. Va., and to the Colorado Agricultural College; a 5,000-lbs. transverse tester to the Dickson Manufacturing Company, Scranton, Pa.; a 1 000-lbs. cement tester to the City Engineer, Salt Lake, Utah; a vibratory testing machine to the Thomson-Houston Electric Company, Lynn, Mass. They have also sold a large number of track and other heavy scales, and Robie screw jacks.

THE locomotives built by the Baldwin Works, Philadelphia, for service through the St. Clair Tunnel, are said to be the heaviest ever built in this country. They are carried on 10 wheels, all coupled and all 50 in. in diameter, the total wheel-base being 18 ft. 3 in. The boiler barrel is 74 in. in diameter and has 280 flues, 2¼ in. in diameter and 13 ft. 6 in. long. The fire-box is 11 ft long and 42 in. wide, and is built to burn anthracite coal. Water is carried in two long side tanks, each holding 1,000 gallons. The cylinders are 22 × 28 in. These engines weigh 195,000 lbs. in working order, giving 19,500 lbs. per wheel.

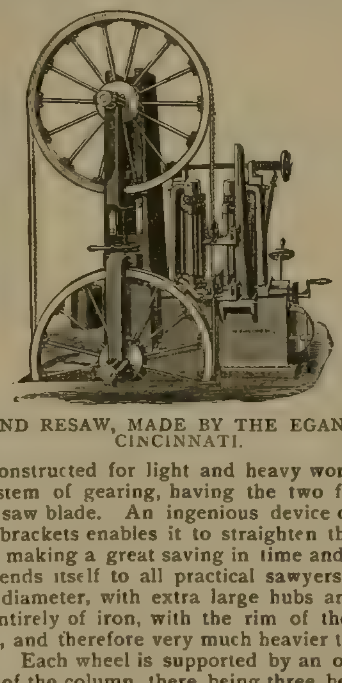
## Asphalt Paint.

To find a paint of lasting qualities, which will prevent the corrosion of iron due to atmospheric agencies, is a problem with which engineers have dealt earnestly for many years. Until within quite recent years little has been known in this country of the valuable properties of asphalt, and to many they are still unknown. In the popular mind it is often confused with certain coal-tar products, which, though similar in appearance, differ essentially from asphalt in character. Asphalt oils are of a non-volatile nature, and are therefore permanent, while, on the other hand, coal-tar and linseed oils are volatile, and, therefore, non-permanent. Herein lies the secret of the paint problem. In order to prevent rust, some substance must be used as a coating for the iron, which is impervious to air and moisture, and it is of equal importance, that it may remain impervious, that it should be unaffected by the heat of the sun and by exposure to the air. It is claimed that there is no other substance in nature which so nearly complies with these severe requirements as asphalt. The so-called asphalt paints which have been commonly used in the past are such only in name. They contain, at best, but a very small per cent. of asphalt, which is incorporated in the form of a pigment and which serves no valuable purpose. Asphalt, on the contrary, should be the main constituent, since the virtue of such a paint depends upon the presence of the permanent asphalt oils. When these so-called asphalt paints are made in light colors, durability becomes subservient to ornamentation. The virtues sought in asphalt are lost by substituting for it the necessarily large quantity of light-colored pigment essential in counteracting the natural dark color of the asphalt.

## The Improved Method of Splitting Lumber.

IN this progressive age there has of necessity arisen, step by step, improved mechanism for band-sawing. The ribbon of steel for many years could not be handled with a degree of reliability; it was an uncertain quantity to depend on; but now the band-saw, large and small, has become an essential factor in the sawing of lumber. The resaw also has become a standard machine, sought for from every section of the country; indeed, there is hardly a first-class establishment having a modern equipment which does not contain the resaw as a valuable adjunct.

The accompanying cut represents a No. 5½ band resaw, built to meet a demand for a machine of great capacity for use in car-building establishments, railroad-shops, etc. It is designed and constructed for light and heavy work, and has an improved system of gearing, having the two front feed-rolls close to the saw blade. An ingenious device connecting the top of roller brackets enables it to straighten the plank while being sawed, making a great saving in time and material, and which commends itself to all practical sawyers. The wheels are 60 in. in diameter, with extra large hubs and spokes, and now made entirely of iron, with the rim of the lower wheel much thicker, and therefore very much heavier than that of the upper wheel. Each wheel is supported by an outside bearing on each side of the column, there being three bearings to both upper and lower shafts. The feed is very powerful, consisting of six large feed-rolls heavily geared, driven by a patent graduating feed, enabling the operator to change the speed instantly by turning a hand-wheel while the board is being fed through the machine. The guides seem to be the best yet devised, and are made so as to support the blade when crowded too fast. The roller back is also a great improvement as now arranged. The capacity of this machine is very great—beyond 20,000 ft. per day—and in the hands of a skillful sawyer and properly fixed for it, there is no trouble in reaching 35,000 or 36,000 ft. per day. It now carries a 6-in. blade, and works with equal facility in hard or soft woods, cutting 36 in. wide, and to the center of 12 in. thick. Several pieces of narrow stuff can be cut placed between the rolls one above the other. The rate of feed is from 0 to 65 ft. per minute; a larger size is built—No. 6—which carries an 8-in. blade, and is specially fitted for saw-mill work and the production of the largest quantities. The success of the No. 5½ has been of a remarkable character. For further information and details address the originators and builders, The Egan Company, Nos. 194–214 West Front Street, Cincinnati, O.



No. 5½ BAND RESAW, MADE BY THE EGAN COMPANY, CINCINNATI.

## The Westinghouse Troubles.

For several months past, the daily press has constantly referred to what it called the financial troubles of the Westinghouse Interests. While it is true that there are several industrial corporations which in one form or another bear the name of "Westinghouse," it is equally true that the "financial troubles" among these companies have been confined to what is known as the Westinghouse Electric & Manufacturing Company, or, in other words, to that company whose business consists in making and vending electrical apparatus.

The Westinghouse Machine Company, for instance, whose business consists in making and selling, through the medium of its agents in every part of the civilized world, its well-known Westinghouse engines, has had no financial trouble, and, to use a current expression, is "not in it!" Instead of curtailing its operations, this old reliable institution is still further increasing its capacity as rapidly and as much as it can. New tool and store-rooms are just approaching completion, and it is hoped by the management, during the coming spring or summer, to be able to add complete new erecting and testing shops fitted with large power cranes and all modern improvements, and which shops will have a producing capacity twice as great as the present ones. To those in want of steam-engines, as well as to those interested in the development, progress and enterprise of American manufacture, we suggest a careful perusal of the advertisement of the Westinghouse Machine Company, which appears elsewhere in this issue.

## Automatic Train Heating.

The first railroad in the world to operate a whole system of trains in which the temperature is automatically regulated whenever steam heat is used, is the Delaware & Hudson Canal Company. Its Belt Line trains between Albany and Troy are all thus equipped with the Consolidated Car-Heating Company's devices. The temperature regulator has been in service since January 1, 1891, and the directions for its use practically are: "Turn on steam to cars from the locomotive and leave every valve on the train entirely alone." The interior temperature of the cars, with ventilators well open, will shortly after steam is turned on rise to 70° and remain there, no matter what the outside temperature may be.

On the invitation of the Consolidated Company a large number of prominent railroad men inspected this system in operation on March 11 and 12. There were present representatives of nearly all the leading lines of the Northern and Eastern States. After carefully watching the operations of the heating apparatus, the visitors were entertained at the Albany Club by the Company.

The exhibition of the car-heating system in use on the Albany Belt Line trains was so successful that the Consolidated Car-Heating Company has extended its invitation to railroad men to visit Albany and inspect that system until April 15, or as long as heat is required in the cars. As the system is in regular every-day use, it can be seen at any time, but if the Company is notified, its representative will meet any visitors who may wish to see the working of the system.

## Baltimore Notes.

Plans for the new bridge to be erected on North Avenue, for the use of the Belt Railroad, the Northern Central and the Western Maryland, have been submitted and approved. The plans were prepared by Mr. Frederick H. Smith, Civil Engineer for the City, and approved by Mr. J. H. Rea, Engineer for the Belt road. The bridge is to be of stone, 400 ft. long, of three arches, with a roadway of 60 ft.; it will cost about $400,000, and will be paid for, jointly, by the City and the Belt Railroad.

The power houses of the Cable Railroad, to run between Druid Hill and Patterson Parks, have been completed, and are ready for the cable, which is expected within the next 10 days.

The South Baltimore Car Works, Curtis Bay, have received an additional order from the Baltimore & Ohio Railroad to make thorough repairs to 50 gondola cars. The United States Rolling Stock Car Works, Hegewich, Ill., have secured a similar order. Having cars repaired by contract is a new feature in the Baltimore & Ohio management. These works are building 250 hopper-bottom gondola cars, of 60,000 lbs. capacity, for the Youghiogheny Coal Company.

A new 10-wheel engine, cylinders 20 × 24 in., with a steel cab, has just been turned out of the Mt. Clare Works. A trial trip will be made on the Philadelphia Division, after which it will be sent to the Trans-Ohio Division. This is the first completed on an order for 10. In addition to these, four 10-wheelers have just been purchased from the Pittsburgh Locomotive Works, for use on the Pittsburgh Division.

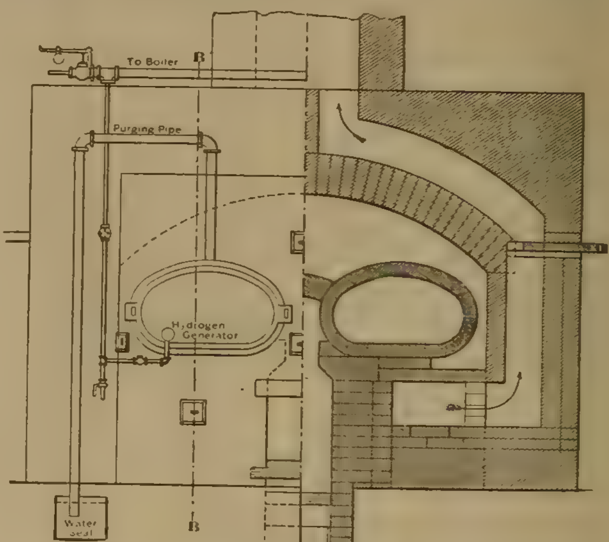
It is said that the Baltimore & Ohio shops at Keyser, W. Va., and Connellsville, Pa., will soon be consolidated with the shops at Cumberland, Md., which is to be the terminus of the Eastern Division instead of Keyser, as at present.

The citizens of Martinsburg, W. Va., are greatly exercised over the rumor that the work of the Baltimore & Ohio shops at that point is to be transferred to Brunswick (old Berlin), where the Company has purchased a large tract of land. Brunswick will be known as the "drilling ground," as all freight trains for Washington, Locust Point, Hagerstown, and all points on the Valley Railroad, will be made up there.

## The Gesner Rust-Proof Process.

The rust-proof process invented by Mr. G. W. Gesner, of New York, has passed the experimental stages, and the inventor has for some time past had a plant in practical operation in South Brooklyn, where a large number of articles have been treated. In this process, it is claimed, no scale or coating is formed, but the body of the surface is converted into a compound of iron, hydrogen and carbon, which will not oxidize, and thoroughly protects the article treated. Moreover, there is no alteration of form, distortion, or warping during the process.

The accompaning engraving shows a half front view and a half section of Mr. Gesner's furnace, from which its construc-




THE GESNER RUST-PROOF FURNACE.

tion can be clearly seen. It consists substantially of a bench of two ordinary gas retorts placed side by side in a furnace heated by a grate. The process itself is conducted in the following manner: The retort being carried to a temperature of 1,000° to 1,200° F., as may be determined by the character of the articles to be treated, the latter are introduced by means of a crane and pulley, care being taken that they do not touch one another. After closing and testing the retort, the heating continues for about 20 minutes. Then steam is introduced into what Mr. Gesner calls a hydrogen generator, shown in the drawings. It is a simple pipe, open at the rear end. Mr. Gesner claims that in the passage of the steam through this generator hydrogen is generated, which fills the retort. This operation goes on for 35 minutes, at the end of which time half a pint of naphtha is permitted to flow into the retort for 10 minutes. The flow of hydro-carbon is then stopped, and the steam which has been allowed to enter the generator during the whole operation is continued for 15 minutes longer. The whole time employed in the operation is, therefore, 1 hour and 20 minutes. The purging pipe, which dips into an open vessel of water, as shown, to the depth of 1½ in., carries off any excess of gases produced in the operation.

In cases where articles treated are ornamental, such as art hardware, they are given a bath of cold whale-oil or paraffine-oil to render them more even in tone. In other articles no oil is used. The plant now established at South Brooklyn is rated at a capacity of 6 tons per day of boiler tubes, 7½ ft. in length, or 2 tons of ornamental hardware, the rate of production of treated goods depending upon the time required for handling them. The average cost of fuel per day is reported by Mr. Gesner to be $1.75, including coal for the boiler.

The following is an analysis, made by Stillwell & Gladding, of New York, of a sample of the surface of cast-iron prepared by the process: Carbon, 1.01 per cent.; hydrogen, 0.22 per cent.; sand, 6.70 per cent, and iron, 66.10 per cent. The chemists add that the iron is present as metallic iron and as oxides of various constitution.

A series of careful tests of iron and steel plates treated by this process shows practically no effect upon the strength and resistance of the metal.

## OBITUARY.

CHARLES KELLOGG, President of the Buffalo Bridge Company, and head of the Kellogg Tube Works, died at his home in Findlay, O., March 14. Mr. Kellogg was well known throughout the country as a civil engineer. He was an inventor of some note, being the originator of the seamless tube which bears his name. He had passed a long and useful life, having reached the age of 75 years.

WILLIAM G. DOUGLAS, who died at his home in Wilson County, Va., March 15, aged 72 years, was one of the oldest civil engineers in the country, and for many years prominently connected with the Baltimore & Ohio Railroad. His first work was on the surveys of the Orange & Alexandria—now the Virginia Midland—Railroad. He made the first survey for the Manassas Gap Railroad, from Manassas to Strasburg, Va., and the preliminary survey for the Rockfish Gap Tunnel through the Blue Ridge for the Chesapeake & Ohio Railroad. He was Civil Engineer on the Baltimore & Ohio, doing work under Chief Engineer Latrobe on the Hancock Division. In 1851 he was Division Engineer on the Central Ohio Railroad from Wheeling to Columbus. He then formed a copartnership, under the firm name of Douglass, Smith & Company, and contracted for building all the cars and bridges of the Central Ohio and other roads. The panic of 1857 broke up his business. In 1872 he was Division Engineer on the Atlantic & Lake Erie Railroad, in Ohio. For some years past he has been retired from active work.

## PERSONALS.

J. P. HOVEY, late of the Northern Pacific, has been made General Foreman of the Baltimore & Ohio shops at South Chicago, in place of C. H. CAMPBELL, resigned.

GEORGE T. JARVIS has resigned his position as Superintendent of the Ohio Division of the Baltimore & Ohio Railroad. His successor is R. W. BAXTER, late Trainmaster.

M. LEWINSON and GEORGE A. JUST have entered into partnership as consulting and contracting engineers, and have established an office at No. 90 Nassau Street, New York.

GARDINER C. SIMS was the special representative of steam engineering at the recent electric anniversary in Providence. Mr. Sims served his apprenticeship at the New York Central shops in West Albany, and after several years' varied experience, joined Mr. Armington in forming the firm of Armington & Sims. Their specialty was the building of quick-running engines, and their type of engine has seemed to be particularly well adapted to electric work, achieving a great success.

WILLIAM F. SHUNK, of Pittsburgh, has been appointed by the Intercontinental Railroad Commission Organizing Engineer, and will have charge of the formation of the parties which are to make preliminary surveys through Central America. The Secretary of War has detailed the following officers for duty in connection with these surveys: CAPTAIN EDGAR L. STEVER, Third Cavalry; FIRST LIEUTENANTS S. M. FOOTE, Fourth Artillery, and ARTER ALLEN, Third Infantry; SECOND LIEUTENANTS A. S. ROWAN, Ninth Infantry, A. T. BUFFINGTON, Seventh Infantry, C. A. HEDEKIN, Third Cavalry, and SAMUEL REBER, Fourth Cavalry. Three other officers are yet to be selected, making ten in all.

## PROCEEDINGS OF SOCIETIES.

**Conference of Railroad Commissioners.**—The Second Annual Conference of Railroad Commissioners was held in Washington, March 3, about 30 persons being present. Judge Cooley, of the Interstate Commission, was chosen President; Mr. George C. Crocker, of Massachusetts, Vice-President, and E. A. Moseley Secretary. Judge Cooley made his annual address, which was a discussion of the railroad problem, with special relation to the present system, or rather lack of system, in making rates.

The report of the Committee on Legislation gave rise to a discussion with regard to securing uniformity in the adoption of automatic couplers and train brakes.

Commissioner Schoonmaker read a paper on the use of private cars, which gave rise to some discussion.

On the second day there was a discussion on the rate question, which ended in the adoption of resolutions in favor of laws regulating rates; such laws in the different States to be made as uniform as possible.

The subject of Car Couplers was taken up, and a representative from the Switchmen's Association made an appeal for uniformity in couplers, with a view to securing safety to trainmen. After discussion it was resolved to appoint a Committee of five to urge upon Congress the need of action to secure the equipment of freight cars throughout the country with automatic couplers and train brakes.

The Committee on Rates was continued, with instructions to report to the next Conference such further facts and suggestions as may be considered best. The Committee on Uniform Safety Appliances was directed to report to the next Conference on the question of National Legislation on Lighting and Heating Passenger Cars.

The Conference adjourned, to meet again in Washington on the second Wednesday of April of next year.

**American Society of Civil Engineers.**—The Secretary announces that the Annual Convention will be held at Lookout Mountain, Tenn., beginning about May 20 next. The detailed arrangements will be announced in a future circular. Members desiring to contribute papers or discussions should send an abstract of the papers to the Secretary not later than April 20, and should advise the Secretary as soon as possible whether they intend to contribute.

AT the regular meeting, March 4, it was announced that the proposed amendment to the constitution relating to local societies had been lost by a vote of 182 to 189. The other proposed amendments had been carried by a vote of 289 to 35.

The following elections were announced:

*Members:* Wilfred E. Cutshaw, Richmond, Va.; George L. Dillman, Winlock, Wash.; Francis L. Hills, Wilmington, Del.; John A. Bensel, George A. Just, New York; Captain James L. Lusk, U. S. Eng., Washington.

*Juniors:* Oscar E. Selby, Louisville, Ky.; John G. Spielman, Paterson, N. J.

Mr R. L. Harris read a paper on Coffer Dams, describing one without timber or iron in its construction. This was discussed by members present.

**Franklin Institute.**—The Committee on Science and Arts of the Franklin Institute has awarded the Elliott Cresson medal to Tinius Olsen, of Philadelphia, for his improvement in Testing Machines.

The Committee has awarded the John Scott legacy medals and premiums as follows: J. E. Wootten, of Philadelphia, improvements in Locomotive Boilers; Ottmar Mergenthaler, of New York, for his improvement of the Linotype; Robert Hadfield, of Sheffield, England, for his discovery of Manganese Steel; Wallace H. Dodge, of Mishawaka, Ind., for his system of Rope Transmission; William Anderson, of London, England, for his process of Water Purification; E. C. Johnson, of New York, for his system of Interior Electric Conduits; J. B. Hannay, of Glasgow, Scotland, and Alfred Shedlock, of New York, for their improved system of illumination known as Lucigen.

**National Electric Light Association.**—At the annual meeting, in Providence, February 17–19, of which some notice was made last month, the following officers were chosen for the ensuing year: President, C. R. Huntley, Buffalo, N. Y.; First Vice-President, James I. Ayer, St. Louis, Mo.; Second Vice-President, M. J. Francisco, Rutland, Vt.; Executive Committee, A. J. DeCamp, Philadelphia; A. J. Corriveau, Montreal; John A. Seely, New York; A. M. Robertson, Minneapolis; C. R. Faben, Toledo; H. H. Fairbanks, Worcester; E. F. Peck, Brooklyn; E. W. Rollins, Denver; J. J. Burleigh, Camden.

It was unanimously decided to hold the next meeting, in August, at Montreal, Canada.

**Master Mechanics' Association.**—The Committee on Locomotives for Freight and Heavy Passenger Service (Pulaski Leeds, Louisville, Ky., Chairman) ask for information as to the relative merits of the mogul and ten-wheel types, limit of weight on a driver and other particulars as indicated by experience.

The Committee on Operating Locomotives with Different Crews ask for information and notes of experience gained in running locomotives with more than one crew ; especially as to cost of fuel and repairs ; also for opinions as to the merit of different systems of running. Answers are to be sent to John A. Hill, 96 Fulton Street, New York City.

Secretary Sinclair has issued the following : " A general index of the annual reports of this Association, from the 1st to the 23d inclusive, has been prepared and is ready for sending out. Members desiring to obtain the Index will receive it free of charge, on applying to the Secretary. The Index is of service only to those who have the back reports and use them for reference.

The Committee on the Car Coupler Question, of which Mr. John Hickey, Kaukauna, Wis., is Chairman, is collecting information as to the working of the M. C. B. standard coupler and the present condition of opinion among the members of the Association in relation to this coupler.

The Committee on Axles, of which Mr. John Mackenzie, Cleveland, O., is Chairman, is collecting statistics as to breakages of iron and steel axles, and as to the service of these axles under locomotive tenders and cars.

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**Illinois Society of Engineers and Surveyors.**—The annual meeting was held in Springfield, Ill., January 28, 29 and 30. A number of interesting papers were presented, among which were Roads and Road Drainage, by T. S. McClanahan ; Office Records, by E. A. Hill ; Map Making, by W. W. Abell ; Pennington's Aerial Ship, by G. C. Harvey ; Straightening and Deepening Water Course, by D. L. Braucher ; Improvement of Public Grounds, by S. F. Balcom ; Water Works of Peoria, by Jacob Harmon ; Government Lock and Dam at Mount Carmel, by G. C. Harvey.

The following officers were elected : President, Arthur N. Talbot ; Secretary and Treasurer, S. A. Bullard ; Recording Secretary, C. M. Richards ; Chairman Executive Committee, D. L. Braucher.

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**Boston Society of Civil Engineers.**—The annual dinner was given at Young's Hotel, Boston, March 10, about 130 members and guests being present. After dinner speeches were made by President Fitz-Gerald, Professors Swain, Drown and Shaler, Messrs. Howe, Spencer, Peters, Stebbins and others.

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At the annual meeting, in Boston, March 18, the Secretary reported a total of 265 members. Reports were received from the standing committees. The following officers were elected for the ensuing year : President, F. P. Stearns ; Vice-President, W. E. McClintock ; Secretary, S. E. Tinkham ; Treasurer, Henry Manley ; Librarian, F. W. Hodgdon ; Director, G. F. Swain.

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**New England Water-Works Association.**—A regular meeting was held in Boston, March 11. Mr. Hiram F. Mills, of the Massachusetts Board of Health, read an elaborate paper on the Relation of Water-Supply to Typhoid Fever, which was discussed at considerable length by members present.

Descriptions were given of a new covered reservoir at Franklin, N. H., by F. L. Fuller ; a new pumping engine at Lynn, by John C. Haskell, and the Malden water-works, by S. M. Allis.

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**Engineers' Club of Philadelphia.**—At the regular meeting, February 21, it was ordered that the amendments to the Constitution be printed and a note taken at the next meeting on the same.

The Secretary then presented, for Mr. Percy T. Osborne, a large view of the Rivermont Bridge at Lynchburg, Va., accompanied by a communication describing this structure.

Mr. Rudolph Hering presented a paper upon the Action of Sea Water on Steel and Iron. This paper was followed by some discussion, but as Mr. Hering proposed to continue the subject at a future meeting, it was resolved that further discussion be postponed until the completion of the paper by Mr. Hering.

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At the regular meeting, in Philadelphia, February 7, Mr. Charles H. Haupt presented an illustrated paper on Photographic Surveying, of which the following is an abstract :

1. The location of points horizontally and vertically from photographs depends, in the first place, on the determination of the position of the point of sight for any view which is at a constant distance equal to the equivalent focus of the lens, and directly opposite the center of the picture. The horizontal projections of points may now be connected with this point of sight, and horizontal angles thus determined. Vertical angles for heights are determined from their tangents.

2. Triangulation of any point in the field may thus be effected ; as it is possible to measure the true angle between this point and some other fixed point from two views taken from different stations.

3. A photographic map of the Schuylkill and Fairmount Park was shown. The map was made from photos taken from each side of the river. A panoramic view of the horizon was taken from each station, each view being oriented from the compass bearing of its center. The base line was on the west bank and was 947 ft. long. A check station was taken on the west bank.

The scale used was 200′ to 1″ and points platted to this scale from the three principal stations checked exactly. Heights also checked up satisfactorily. The field work took but eight hours ; platting about three days.

There was considerable discussion of this paper.

The Secretary presented, for Mr. J. M. Stewart, a paper by Mr. J. Bernard Walker upon a Boltless Rail Joint. Mr. Stewart, who is Chief Engineer of the Oregon Pacific, is about to try it on his road, and considers that one of its principal values is that such rail joints will be cheap to maintain, as the constant tightening of bolts is not, in his opinion, necessary.

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**Civil Engineers' Club of Cleveland.**—At the regular meeting, February 10, Professor Frank H. Neff was elected a member. The Committee on Nominations reported two lists of candidates. A Committee was appointed to arrange for the annual meeting and dinner.

Mr. H. M. Kingsley read a paper on Surveys for the Cleveland Water Works Tunnel, in which he said that the original location was in a straight line from the shore shaft to the crib in the lake, but on account of striking quicksand, some detours were made, complicating the location. On account of the unequal settling of the crib, throwing the shaft out of plumb, the direction at that end was obtained from two plumb lines only 6 ft. 4 in. apart, yet the intersection of the two headings was only 6 in. north of the calculated point. The measured length of the tunnel was only 0.096 ft. shorter than the calculated length in a distance of 7,100 ft. After the completion of the tunnel test levels were run connecting with bench marks upon the shore end with the lake end, and they were found to differ only by 0.016 ft.

The paper was illustrated by specimens of wood, bark and nuts found at a depth of 60 to 80 ft. below the surface ; also by a map showing the location of the tunnel as originally laid down and as finally built ; also the location and soundings for the proposed extension 2½ miles further into Lake Erie.

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The eleventh annual meeting was held at the Club Rooms, March 10. A brief memoir of Mr. Joseph M. Blackburn, member of the Club, lately deceased, was presented, and resolutions of respect were adopted.

Ballots for the election of officers for the ensuing year were canvassed, and the following officers elected : President, Joseph Leon Gobeille ; Vice-President, M. E. Rawson ; Secretary, A. H. Porter ; Treasurer, N. P. Bowler ; Librarian, C. M. Barber ; First Director, F. C. Osborn ; Second Director, S. J. Baker.

A revised constitution was adopted. The retiring officers presented their annual reports. The President's report showed the Club to be in excellent condition, and its work during the past year equal to that of any year previous, and the prospect for the future bright and flattering.

The Secretary's report showed that the total membership now reaches 157, a gain of 20 during the past year. There were two deaths during the year and only one resignation, and no member was dropped for non-payment of dues. There were 13 papers read before the Club during the year, and there was one discussion upon a technical subject.

The Treasurer's report showed the finances to be in a healthy, substantial condition.

The Librarian's report showed that more room is urgently demanded for the better accommodation and proper arrangement of the Engineering Library, that is slowly but steadily growing.

The Chairmen of the various Committees on programme made brief reports upon the progress made in the different departments of Engineering during the year. Three of these reports were especially interesting, that of Professor C. L. Saunders on Surveying and Civil Engineering, that of Mr. Walter Miller on Mechanical Engineering, and that of Professor C. S. Howe on some recent discoveries in Astronomy.

The various Committees on programme for the ensuing year were appointed. A vote of thanks was extended to the retiring officers.

**Engineers' Club of Cincinnati.**—At the regular meeting, February 19, there was a discussion on the question of the most equitable method of assessing and calculating the cost of street improvements, the point being whether such improvements should be paid for by assessing the cost upon abutting property or from a general fund.

Colonel Latham Anderson read a paper on a Single Trap System of House Drainage, which included a general discussion and criticism of the modern system of house drainage and a description of a proposed plan for the use of a single trap between the sewer and the house. This was generally discussed.

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**Engineering Association of the South.**—At the regular meeting, in Nashville, Tenn., February 12, the committee appointed to prepare a memorial to the Legislature for the repeal of the Tennessee law levying a special tax on architects and engineers, reported that answers from 38 States showed that no tax was levied on these professions.

The Committee on Highways recommended that a standing committee be appointed of one member from each State represented in the Association to secure as frequently as possible papers from members on this subject to be read, discussed, and then printed and generally circulated. The report was approved.

Mr. Charles J. Norwood, of Frankfort, Ky., was chosen a member. The death of Mr. Eben Pardon was announced.

Mr. J. B. Marbury read a paper on Weather Forecasts, giving an ac ount of the system adopted by the United States Signal Bureau.

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At the regular monthly meeting in Nashville, Tenn., March 12, the standing Committee on Highways was announced as follows: J. R. Carter, Birmingham, Ala.; B. T. Burchard, Fernandina, Fla.; A. V. Gude, Atlanta, Ga.; E. L. Corthell, Chicago, Ill.; C. O. Bradford, New Albany, Ind.; John McLeod, Louisville, Ky.; J. Kruttschnitt, New Orleans, La.; William Stickney, Buffalo, N. Y.; W. Starling, Greenville, Miss.; W. H. Bixby, Wilmington, N. C.; S. Whinery, Cincinnati, O.; E. C. Lewis, Nashville, Tenn.; C. W. Richardson, Richmond, Va. This Committee includes one member from each State represented in the Association.

President Atkinson invited the Association to hold its main meeting at Earlington, Ky., in the western coal-field, and the invitation was accepted.

Mr. C. J. Norwood, State Inspector of Mines of Kentucky, read a paper on Mine Inspection, giving a complete exhibit of the present status of the 91 mines in Kentucky subject to inspection, both as to the general character of the mines, the kind of ventilation and safety appliances used. The inspection of mines in the States was first begun in 1884. At present ventilation by natural means is prohibited. Fans are used at 16 mines and ventilating furnaces at the rest. The law requires 100 cub. ft. of air per man per minute to be delivered into mines, and headings are not allowed to be opened more than 60 ft. in advance of air supply. It also requires safety cages on all hoisting cages. Fire-damp has been found in only 10 mines in the State, and explosions have occurred in only two. The principal accidents have been caused by the falling of roofs, blasting and dust explosions. Maps of the workings of each mine are required to be filed twice a year. The law has been generally complied with by mine owners without compulsion, and the sentiment is in favor of close inspection.

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**Alabama Industrial & Scientific Society.**—The first regular meeting was held in Birmingham, January 28. It was stated that 85 members have joined the Society. The officers are: President, Cornelius Codle, Jr.; Vice-Presidents, Thomas Seddon, W. E Robertson, C. P. Williamson, M. C. Wilson, and Horace Harding; Secretary, William B. Phillips; Treasurer, Henry McCalla.

The President made an address on the Work of the Society, and the best means of carrying it out. Mr. W. Haskell read a paper on Mine Surveying, which was discussed.

Resolutions were passed requesting the President to present a petition to the Legislature for an increased appropriation for the Geological Survey of the State. The next meeting will be held at Anniston in April.

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**Civil Engineers' Society of St. Paul.**—The regular meeting, February 2, was the joint meeting of the St. Paul and Minneapolis Societies, and was opened by a dinner, followed by an address of welcome to the visitors. A committee was nominated to prepare a memorial of the late J. L. Gillespie, and the Secretary was directed to accept the gift of 28 volumes from his estate.

Mr. Van Duzee, of the Minneapolis Society, read a paper on Sewer Construction in Minneapolis, giving the history and the general plan of the system. There are now 80 miles of sewer in the city, 20 miles of which were built last year, wholly by day labor. The greater part of the storm water is carried off by intercepting sewers, and all the sewers are flushed automatically.

This was followed by a discussion on Mr. Münster's paper, read at the January meeting, on a Short Method to Results obtained by Gordon's Formula, his method being generally indorsed.

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At the regular meeting, March 2, it was decided to accept the offer of rooms in the Court House; and other business was transacted, including arrangements for future meetings. John B. Hawley and C. F. Hollingsworth were elected members.

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**Engineers' Club of Duluth.**—This Club was organized at Duluth, Minn., February 21, when the following officers were elected: President, William B. Fuller; Vice-President, L. F. Brewster; Secretary, M. W. Lewis; Treasurer, F. B. Edwards; Librarian, S. A. Parsons.

It was decided to hold regular meetings on the second Saturday of each month.

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**Engineers' Club of St. Louis.**—At the regular meeting, February 4, it was resolved to purchase the library of the late Mr. Whitman, the money to be raised by subscription.

Professor M. A. Howe read a paper on Strength of American Vitrified Sewer Pipe, giving the result of a number of experiments made to determine the strength of such pipe. These experiments included tests to determine what load of water would burst the pipe; to ascertain the behavior of the pipe when subjected to sudden blows; to determine the load a length of pipe would sustain at the center when supported at both ends; to determine the maximum pressure pipe will stand when surrounded by sand, and to determine the strength of cement joints. This paper was generally discussed by members present.

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At the regular meeting, March 4, A. J. O'Reilly and I. O. Walker were elected members. A memorial of the late S. F. Bennet was presented. The Committee was instructed to purchase portraits of Captain J. B. Eads and C. Shaler Smith.

Mr. N. W. Perkins, Jr., read a paper on Brick-making Machinery, which sketched the history of brick-making, and described in detail a number of the machines now in use. This paper was generally discussed by members present.

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**Engineers' Club of Kansas City.**—The officers of this Club elected at the February meeting are: President, F. E. Sickles; Vice-Presidents, F. W. Tuttle and W. Kierstead; Treasurer, W. Stone; Librarian, V. Wittmer; Directors, J. A. L. Waddell and E. J. Farnsworth.

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**Denver Society of Civil Engineers.**—The officers of this Society for the ensuing year are: President, George G. Anderson; Vice-Presidents, R. D. Hobart and J. S. Titcomb; Secretary and Treasurer, George W. Angell. The papers read so far this season have been as follows:

February 24, The Cañons of the Colorado, by W. H. Graves.

March 10, Recent Improvements in Mining Machinery, by John McNeil, E. J. Hall, and George L. Ramsay.

March 24, Underground Surveying, by George Holland, J. S. Luckraft, and L. S. Preston.

The President's annual address was delivered at the meeting of February 10. In the April meetings papers will be presented on Bridges and on Irrigation.

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**Montana Society of Civil Engineers.**—On January 17 the members of this Society made a special visit to the works of the Montana Company, at Marysville, where there was a general inspection of the mills and mines of the Company and a short meeting was held.

In the evening a meeting was held in Helena, at which the annual report of the Secretary was submitted showing the expenditures during the year to be $272, and a balance of $63 on hand. The Association has now 57 active and three associate members, a net increase of 8 during the year. Ten regular and two special meetings were held.

The following officers were then elected for the ensuing year: President, Elliott H. Wilson; First Vice-President, John Herron; Second Vice-President, George H. Robinson; Secretary and Librarian, James S. Keerl; Treasurer, Albert S. Hovey; Trustee for three years, W. W. de Lacy.

The new President then made a short address. The meeting was concluded by a dinner at the Hotel Helena, which was much enjoyed, and at which toasts were proposed and responded to as follows: "Old Times in the Northwest," Colonel W. W. de Lacy; "Future of Engineering," John Herron; "Matrimony and its Relations to Engineering," A. S. Hovey; "The Railroad Engineer," H. J. Horn, Jr.; "Mining Engineering," A. B. Knight and C. W. Goodale; "The Law," Judge Hiram Knowles; "Engineering Societies," J. S. Keerl; "The Ladies," E. H. McHenry; "Surveying in 1730," Judge H. H. Blake.

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**Technical Society of the Pacific Coast.**—At the regular meeting in San Francisco, February 2, Mr. J. Richards read a paper on Abrasive Cutting in the Mechanic Arts, which was discussed. This is to be followed by another paper on the same subject.

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At the regular meeting, March 6, Constructor A. W. Stahl, U. S. N., read a paper on the Theory of Wave Motion, which was generally discussed.

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**Tacoma Society of Civil Engineers.**—At the regular meeting, in Tacoma, Wash., February 20, Walter M. Bosworth read a paper on Electricity as a Motive Power.

Mr. J. V. Browne read a paper on Comparative Strength of Washington and Eastern Timber, in which he said that the fir and pine of Washington were noted for their great strength.

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**Southern & Southwestern Railway Club.**—A regular meeting was held in Chattanooga, Tenn., February 19. The first subject for discussion was Brakes Hung to the Car Body *vs.* those Suspended from the Truck. This was opened by a paper prepared by Mr. J. J. Casey, who advocated hanging from the truck. The discussion was continued by Messrs. Meehan, Gibbs, Leeds, Burgess, Setchel, Howson, Patterson, Thomas and others, a variety of views being expressed.

The second subject for discussion was Means of Preventing the Forgery of Defect Cards, upon which a number of members spoke. Mr. Gibbs gave a number of instances in which forged cards had been sent with cards, and a specimen card was presented so arranged as to make alterations difficult or impossible.

It was decided to hold the next meeting in Memphis, Tenn., and the subjects chosen were Breaking of Side Rods, and Exhaust Nozzles.

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**Western Railway Club.**—At the January meeting, in Chicago, Mr. W. H. Marshall read a paper on Vertical Plane Couplers and Air-Brakes, which called out a long discussion. Mr. D. L. Barnes read a short supplement to his paper on the same subject, which was presented at the December meeting. The main point made in the discussion was that the use of the vertical plane coupler was very important in connection with the introduction of air-brakes on freight cars.

Mr. J. N. Barr then read an interesting paper on Irregular Wear of Locomotive Tires, which was accompanied by a number of diagrams and tables. The discussion of this paper was postponed until the next meeting.

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**Northwestern Track & Bridge Association.**—The regular meeting was held in St. Paul, February 13. Discussions were had on Mr. Pearson's paper on the Temporary Expediences in Case of Fire and Washout, and also on Rail Joints.

Mr. B. T. McIver read a paper on the Best Clamphead for Lower Chord of Howe Truss Bridges.

At the annual meeting in St. Paul, the following officers were elected: President, John McMillan; Vice-President, A. Amos; Secretary, D. W. Meeker; Treasurer, John Copeland. The President made an excellent address, reviewing the year's work.

The paper on Preserving Ties presented at the previous meeting was generally discussed.

Mr. J. Kindelan read an interesting paper on Rail-joints, describing a large number of joints devised and in use.

## NOTES AND NEWS.

**A New Pavement.**—Some time ago an experimental section of street pavement composed of wooden blocks and cast-iron supporters was laid down in Sheffield, England. The accompanying engravings, from *Iron*, illustrate a further experiment in the same town on similar lines, but instead of cast-iron, as in the former case, wrought steel is used in combination with wood. In place of the cast-iron upright stud of a cruciform section previously used at the angles of the blocks, there is

FIG. 1.

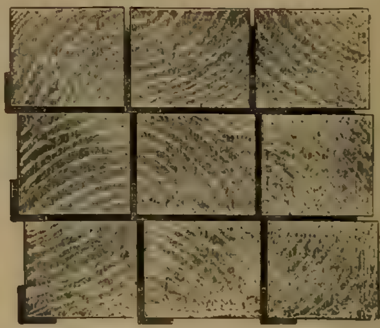


FIG. 2.

now an angle-piece of steel (fig. 1) having a base or foot which rests directly on the concrete foundation. The advantages of steel over cast-iron are obvious, but the difficulty has been to adapt steel in such form as would be producible without making the cost so great as to preclude its general adoption. The first piece of combined wood and iron paving has now been in use three years, and shows little or no sign of wear. The piece described in our previous notice is still in use under exceptionally heavy traffic. The third piece, which comprises about 100 square yards, has been laid down in Queen Street, Sheffield, where there is a great amount of traffic. Half of it is in cast-iron, but of much lighter construction than that in Savile Street, the other half is in steel, as shown in fig. 2 of our engravings. It has been in use seven months. This pavement is made by the Carmaxill Road Paving Company, of Sheffield.

**Heating Metals by Electricity.**—An illustration of a simple adaptation of the transformability of electrical energy to an industrial end is afforded by a recent German patent for a process and apparatus for superheating metals already fused. A glance at the accompanying figure (fig. 1), which represents a longitudinal section of the apparatus, will show the plan adopted. A cast-iron box *A*, capable of being divided into two parts, is packed full of any suitable refractory material,

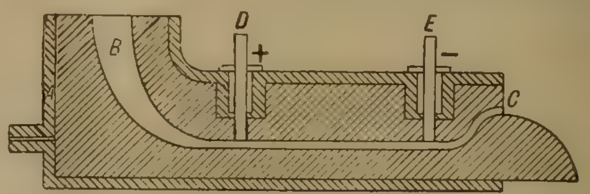



FIG 1.—Apparatus for Superheating Molten Metal.

such as sand, fire-clay, or magnesia, and a channel *B* formed therein, funnel-shaped at the top, becoming parallel-sided when it has reached a horizontal position and taking an upward curve at *C* before the end of the box is reached. Two electrodes *D* and *E* pass through stuffing-boxes packed with asbestos or some similar material at once capable of withstanding heat and of acting as an insulator. The metal to be superheated flows in at *B*, passes along the horizontal channel, serves as a conductor between *D* and *E*, and has its temperature raised thereby, and escapes at *C*. Consider the simplicity of such a method compared with any more usual mode of heating. With a common furnace fuel would have to be burned in a refractory chamber surrounding the vessel containing the liquid to be superheated. If a continuous flow were required this vessel would take the form of a tube, through whose walls every unit of heat imparted to the liquid would have to be transmitted, while the surface from which radiation could take place would not be that of the tube itself but of the necessarily larger chamber surrounding it.—*London Electrician.*

**Pumping Work at Bay City.**—The pumping plant of the water-works at Bay City, Mich., under charge of Superintendent E. L. Dunbar, includes one Gaskill horizontal compound condensing crank and fly-wheel pumping engine, maximum

capacity 5,000,000 gallons in 24 hours; one Holly quadruplex compound condensing crank and fly-wheel pumping engine, maximum capacity 3,000,000 gallons in 24 hours; one horizontal high-pressure piston engine, driving through gears two No. 10 Holly rotary pumps, maximum capacity 2,500,000 gallons in 24 hours. There are three horizontal return tubular boilers, each 5 ft. 6 in. diameter and 16 ft. long, with 105 tubes 2½ in. diameter. The boilers are set in separate brick arches and the fuel used is slabs and edgings from the saw-mills.

The total work done by the pumps last year was as follows:

| | Time run. | Water pumped. |
|---|---|---|
| Gaskill engines........ | 8,674 hrs. 0 m. | 975,759,367 gals. |
| Quadruplex engines.... | 87 " 54 " | 11,885,445 " |
| Rotary pumps......... | 19 " 19 " | 1,126,641 " |
| Total | 8,781 hrs. 13 m. | 988,771,453 gals. |

Of the water pumped there was, under ordinary or domestic pressure—average 41.6 lbs.—970,324,930 gallons; under fire pressure—average 86.5 lbs.—18,446,523 gallons. The greatest quantity pumped in one day was 3,510,694 gallons; the least, 2,038,487 gallons.

There was used 2,822 cords of wood—estimated equal to 776 tons of coal—the average cost being 65.8 cents per cord. The cost of pumping was as follows:

| | For fuel. | Total. |
|---|---|---|
| Total cost for the year .............. | $1,845.00 | $6,077.63 |
| Cost per million gallons pumped...... | 1.87 | 6 15 |
| Cost per million gallons raised 100 ft... | 1.64 | 5.39 |

The total cost includes fuel, supplies, salaries, and repairs. The average lift of all the water pumped was 114 ft. from the surface of the water in the wells.

The quantity of water supplied was the greatest ever used in one year. The record of the works for the year was an excellent one.

**The Sault Water-Power.**—The citizens of Sault Ste. Marie, who bonded the town for $500,000 to help the water-power project, expect English capitalists to take hold of the enterprise. The report of Colonel Hope, a celebrated Scotch engineer, is entirely favorable to the scheme, and was made at an expense of $20,000. Colonel Hope made, for the first time, a survey of the amount of water which passed through the river. On the plans of the survey the force will be 70,000 H.P., which will be placed to consumers at $6 per H.P. per annum. The principal use of the power, according to plans of the promoters, will be in grinding pulp, the surrounding country furnishing immense amounts of spruce and balsam, which make the very best of paper fiber. It will doubtless also be used for running stamp-mills for the reduction of lean silver, nickel and copper ores, which would not pay if the reduction was made by steam. It is proposed to line the canal with stone at an expense of $2,000,000 and make it as solid and permanent as possible.—*Marine Review.*

**The Greatest Ocean Depths.**—Rear-Admiral George Belknap, U. S. N., read a paper in October before the Asiatic Society of Japan, on the depth of the Pacific on the east coast of Japan, with a comparison of other ocean depths. He gave interesting details of his own experience while surveying a cable route on the east coast of Japan and along the Aleutian chain and Alaska to Puget Sound. His conclusions are that a trough of extraordinary depth and extent exists along the east coast of Japan and the Kurile Islands. From his own investigations and a study of the data obtained by previous researches, Admiral Belknap advances the interesting proposition that "as a rule the deepest water is found not in the central parts of the great oceans, but near, or approximately near, the land, whether of continental mass or island isolation."

The *Bulletin* of the American Geographical Society, reviewing the work done, shows that the *Challenger* discovered the great depression of 4,075 fathoms in the North Pacific near Guam; that the United States Coast Survey steamer *Blake* found a depth of 4,561 fathoms in the North Atlantic near Puerto Rico; and that the British surveying steamer *Egeria* found depths of 4,428 fathoms, 4,295 fathoms, and 4,530 fathoms near the Friendly and Cook Islands in the North Pacific.—*Goldthwaite's Geographical Magazine.*

The greatest of these ocean depths, that found by the *Blake*, is equal to 5.183 miles, showing that the inequalities of the ocean bed are fully as great as any on the land surface.

**The Beginning of Iron Making in America.**—It is certain that at Lynn, in the Province of Massachusetts Bay, was cast, in the year 1645, the first piece of hollow ware made in America —"a small iron pot capable of containing about one quart." This pioneer of all American-made castings was in existence in 1844, but recent efforts to ascertain its whereabouts have been unsuccessful. The works at Lynn appear to have been very prosperous for a number of years; but after a time they became unpopular, owing to the flowage of lands by their dam, and the great destruction of timber for fuel.

The Rev. William Hubbard, writing in 1677, says they were "strenuously carried on for some time, but at length, instead of drawing out bars of iron for the country's use, there was hammered out nothing but contentions and lawsuits." Just about this time Samuel Butler was writing his great poem in which he makes Hudibras say:

> Alas! what perils do environ
> The man who meddles with cold iron!

a reflection which has been sadly appropriate in the case of too many American iron works.

After the establishment of this first successful "furnace" and "foundery" at Lynn, works for the manufacture of iron were erected in other parts of New England, and thence the business spread into New York, New Jersey, Pennsylvania, and Maryland. During the "French War" (1755) there were a number of furnaces in operation at which "cannon, bombs, and bullets" were made in great quantity, and many of these iron works furnished similar supplies to the Continental Army during the Revolution.—*W. F. Durfee, in Popular Science Monthly for December.*

**Sand-Drier for Locomotives.**—The accompanying illustrations show an improved sand-drier for locomotives, invented by Mr. J. Macdonald, of Tokyo, Japan, and which is intended

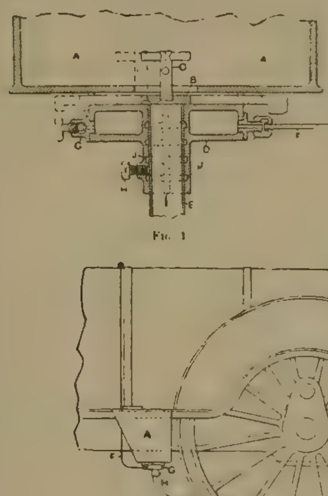


Fig. 1

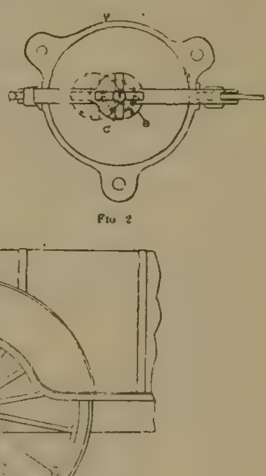


Fig. 2

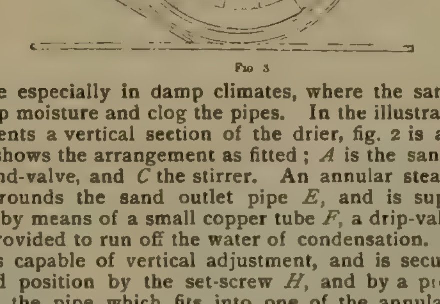


Fig. 3

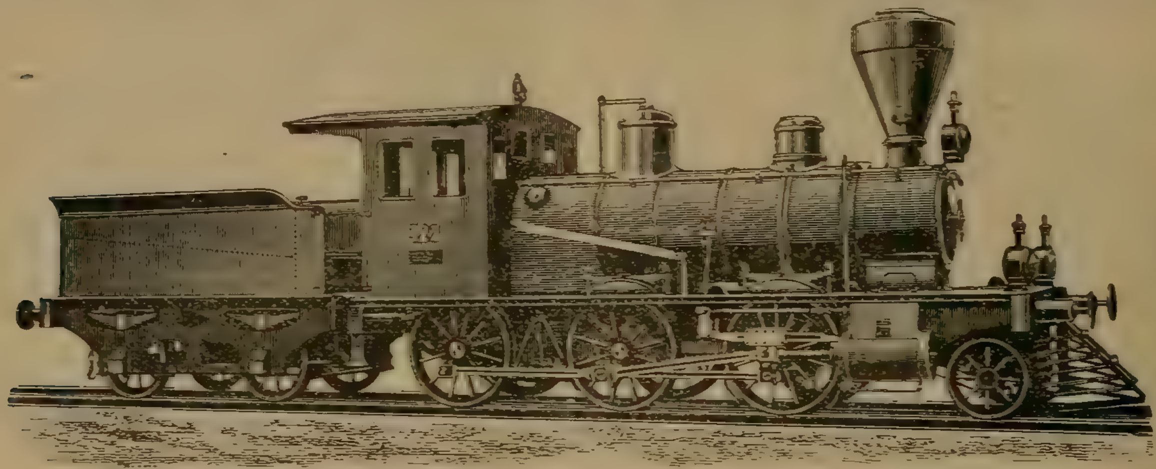
for use especially in damp climates, where the sand is apt to take up moisture and clog the pipes. In the illustrations, fig. 1 represents a vertical section of the drier, fig. 2 is a plan, and fig. 3 shows the arrangement as fitted; *A* is the sand-box, *B* is the sand-valve, and *C* the stirrer. An annular steam chamber *D* surrounds the sand outlet pipe *E*, and is supplied with steam by means of a small copper tube *F*, a drip-valve *G* being also provided to run off the water of condensation. The sand-pipe is capable of vertical adjustment, and is secured in any desired position by the set-screw *H*, and by a projection or nib on the pipe which fits into one of the annular recesses. We are informed that this apparatus has been in use on a large number of locomotives for some time in humid climates, with complete success. One line on which it is used has a prevailing gradient of 66 ft. to the mile for 14 miles.—*Industries.*

**Price of Gas in England.**—The *Engineer* says that the prices of gas supplied by the various companies throughout the country during the past year varied from 1*s.* 9*d.* = 40 cents per 1,000 ft. at Plymouth to 7*s.* 6*d.* = $1.80 at Walton-on-the-Naze. The prices of gas supplied by local authorities varied from 1*s.* 10*d.* = 44 cents at Leeds to 6*s.* 3*d.* = $1.50 at Bethesda, in North Wales. It is noteworthy that while Plymouth at 1*s.* 9*d.* = 40 cents and Leeds at 1*s.* 10*d.* = 44 cents made a profit, Bethesda at 6*s.* 3*d.* = $1.50 did not produce sufficient revenue to pay expenditure. Local authorities average 267 cub. ft. per ton of coal carbonized less than companies.

In New York the price is now $1.25 per 1,000 ft. Consumers will wish that a pipe line was possible between here and Plymouth.

**A Light Mogul Locomotive.**—The accompanying illustration shows one of 30 locomotives built by the Swiss Locomotive & Machine Works at Winterthur, Switzerland, for the Uleaborg Extension of the Finland State Railroads. This extension runs to Uleaborg, which is on the Gulf of Bothnia, in latitude 65° N., and is notable as being the most northerly railroad in the world, with the exception of one line in Sweden.

The engine is distinctly of the American type of mogul engine, with outside cylinders, Bissell truck, etc.; the main differences are in the use of the plate frame and the four-wheeled tender. The engine has cylinders 15 in. in diameter and 20 in. stroke; the driving wheels are 48.8 in. in diameter, and the truck wheels 30.7 in. The total wheel-base is 18 ft. 8 in.; the rigid wheel-base 12 ft. The gauge of the road is 5 ft.



The boiler is built to carry a working pressure of 150 lbs.; it is of steel, while the fire-box is of copper, made deep and nearly square. The fuel used is wood. The forward driving wheel springs are equalized with the truck. The engine weighs 56,400 lbs. in working order, 46,400 lbs. being on the drivers.

The tender is carried on four 36-in. wheels. The tank, which holds 990 galls., is box-shaped, leaving the upper part of the tender open for wood. The tender weighs 30,900 lbs. in working order.

**Baltimore Belt Tunnel.**—Work has been begun on the fourth section of the new Baltimore Belt Line by the contractors Ryan & McDonald. This section includes the Howard Street tunnel, which is the most important work on the line. Another heading will shortly be begun from the south end of the tunnel, so that work will be progressing at both ends at once, and it is the intention to sink several shafts to hasten the progress of the work. In driving this tunnel temporary timber supports will be used to support the roof and sides. The excavation will be large enough to allow for a masonry lining, which will be necessary throughout the length of the tunnel.

**Testing Paving-Stones.**—The following plan of testing the comparative value of paving-stones is adopted at the Paris Laboratory for Testing Materials: A sample of the rock of regular form is placed upon a horizontal plate, rotating round a vertical axis, and pressed against it by suitable contrivances. The wear is then compared with that of a standard material under the same conditions. The coefficient of wear is the proportion between the volumes worn, which can easily be ascertained by weighing the specimens, and determining the volume from this weight, and the specific gravity of the material in question. The rotating surface is cast-iron. The two specimens, viz., test piece and standard, are placed at opposite ends of a diameter of the rotating plate, against which they are pressed by equal weights. The standard used is Yvette sandstone, and first-class materials have a coefficient of from 1 to 1.40, while with second-rate materials the coefficient is between 1.40 to 2.40; if the wear is greater than that represented by the latter figure, the material is rejected. An additional test is made by placing specimens of the stones to be tested in a cylinder, which, like those used in clearing scrap iron from rust, is mounted and rotates on an axis which does not coincide with its center of figure. The amount of detritus produced after the material has been treated for a certain time in this machine is compared with that from a standard rock under the same conditions.

**Aeronautics and Electricity.**—In order to show the application of electricity to aerial navigation, a captive balloon, capable of seating 10 persons, will be exhibited by Captain Rodeck at the forthcoming Frankfort Exhibition. The pulley which controls the ascent and descent will be operated by an electric motor, and a telephone wire will enable conversation to be carried on between those in the balloon and the people at the starting-point below. Experiments will be made with the view to the steering of the balloon by electricity, and in the filling of the balloon with electrically prepared water gas. Messrs. Siemens & Halske will make the electrical apparatus.

**The Malleco Viaduct.**—The accompanying illustrations, figs. 1 and 2, for which we are indebted to our contemporary, *La Nature*, represent a viaduct which was opened for traffic in October last, and which conveys the Chilian State Railroad across a deep valley, at the bottom of which runs the River Malleco, near Collipulli, in the southern part of Chili. The viaduct, which is constructed entirely of steel, has a height of 333 ft. from the level of the river, and is composed of five spans, each 232 ft. in length. The total length of the viaduct is 1,419 ft., the length of the steel portion being 1,160 ft. The depth of the girders forming the superstructure of the viaduct is 23½ ft., while the rails are laid at a height of about 327 ft. from the level of the river. The total weight of the viaduct is 1,550 tons. The designs were prepared by a Chilian engineer, Mr. V. Aurelio Lastaria, and the whole of the steel work, which was erected under the supervision of Mr. E. Vigneaux, was supplied by Messrs. Schneider & Company, Creusot, France.

The great difficulty of this undertaking was due to the extreme steepness of the banks of the ravine, and a great deal of time was taken in getting the material into position.

THE RAILROAD AND

ENGINEERING

JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, MAY, 1891.

THE offices of the RAILROAD AND ENGINEERING JOURNAL were removed on May 1 to the new building Nos. 45, 47 and 49 Cedar Street. The correct address of the JOURNAL is now, therefore, No. 47 Cedar Street, New York City.

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AN important order has been issued by the Secretary of the Navy vacating all positions of foremen and master mechanics in the New York Navy Yard from June 1. These positions are thereafter to be filled by competitive examination, and a board has been appointed to make the examinations and pass on the qualifications of the candidates. The examinations will be open to all comers, who are required to make application to the Commandant of the yard by May 7, and to present evidence of citizenship, good character, and of the fact that they have had experience in that kind of work in which they seek employment.

It is understood that this is the beginning of the general application of the Civil Service system to all the navy yards, and that appointments to positions in all grades are hereafter to be based solely on qualifications for and experience in the work. There is no doubt that a full application of this system will secure a much better force than has heretofore been employed, and that the benefits of the plan will soon be apparent, especially in the great construction yards at New York and Norfolk. The examinations for the Norfolk Yard will be made by the Board a month later than those at New York.

---

IRON production continues to decrease somewhat, the *American Manufacturer's* report for April 1 showing 231 furnaces in blast on that date, having a total weekly capacity of 113,316 tons of pig iron. This is a decrease during April of 7.6 per cent. in the number of furnaces and of 6.2 per cent. in capacity. As compared with April, 1890, the decrease in number of furnaces in blast was 36.1 per cent., and in capacity 39.6 per cent.

Part of the reduction in April was due to the coke strike in Pennsylvania, where a number of furnaces now out of blast will start up as soon as they can obtain a steady supply of fuel. The Southern furnaces generally continue active and their production large.

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THE first railroad bulletin issued by the Census Office is on the railroads of New England, and it gives the following comparative figures for the business years 1880 and 1889:

| | 1889. | 1880. | Increase, per cent. |
|---|---|---|---|
| Mileage of roads | 6,942 | 6,021 | 15.7 |
| Locomotives in use | 2,151 | 1,616 | 33.1 |
| Passenger-train cars | 3,803 | 2,622 | 45.1 |
| Freight cars | 49,140 | 35,051 | 40.3 |
| Passengers carried | 103,374,387 | 52,221,338 | 97.9 |
| Passenger-miles | 1,551,590,703 | 872,106,355 | 77.9 |
| Tons freight carried | 35,295,896 | 24,003,967 | 47.0 |
| Ton-miles | 2,313,321,712 | 1,394,392,088 | 65.9 |

Railroad traffic in New England has probably changed less than in any other section of the United States during the past decade, but there are still some marked differences in the table. Thus, with an increase of only 15.7 per cent. in mileage there was a gain of 77.9 per cent. in passenger traffic, and of 65.9 per cent. in freight traffic. The average freight haul increased considerably, showing a relative gain in through business, but the average passenger journey decreased considerably, a result probably of the great growth of cities and increase in suburban residents.

The average passenger fare decreased from 2.19 to 1.92 cents per passenger-mile, and the average freight rate from 1.84 to 1.47 cents per ton-mile. The tendency to lower rates exists here as elsewhere, but the reduction in freight rates was less marked, owing to the greater proportion of local and high-class freights.

The average number of employés per 100 miles of line in 1889 was 761, of whom 220 were employed in maintenance of way and structures, 121 in maintenance of equipment, 398 in conducting transportation, and 22 in general administration. In ten years the number of employés per 100 miles has increased about 35 per cent., but the proportion to traffic has slightly decreased.

The average equipment per 100 miles of line last year was 33 locomotives, 58 passenger cars, and 752 freight cars. It is to be noted that there has been a considerable increase in the average work done by both locomotives and cars.

The increase in the total income for ten years was 41.7 per cent., but that in expenses was somewhat greater, so that there was an increase of only 28.2 per cent. in the net earnings.

---

IN a curious paper recently read before the Geographical Society in Paris, M. de Lapparent, a well-known French Geologist, has made a careful calculation of the amount of solid matter yearly carried off into the ocean by the action of the rivers of the world and by other causes. He estimates that the reduction of the average height of the surface of the solid land is 0.000155 meter (0.006 in.) each year. Making allowance for the corresponding rise in the bed of the ocean, and taking no account of the occurrence of volcanic and other exceptional phenomena—the general tendency of which is to hasten the process of disintegration—M. de Lapparent thinks that in about 4,500,000 years the solid land will have ceased to exist, and the surface of the earth will be covered with water. By that time our descendants of the human race will have disappeared, unless they should gradually develop into a purely aquatic species.

The prospect is too remote, however, to cause us any anxiety, or to make a market for any patents for marine dwellings or floating islands for enterprising inventors.

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THE first surveying parties for the Intercontinental Railroad left New York early in April, under charge of Messrs. W. F. Shunk and J. Imbrie Miller as Supervising Engineers. The parties included a number of engineers, and will begin their operations in Ecuador. Other parties will be put in the field shortly in Central America.

---

IN our account of the surveys of the Siberian Railroad, it was stated that the building of the Oussouri section, which extends from Vladivostok, on the Pacific Ocean, to Grafskaia, on the Oussouri, and which is to connect the chief Russian port in Eastern Siberia with the extensive navigable system of the Amour, had been postponed for the present. This statement was true at the time it was written, but since then arrangements have been made for the immediate commencement of work. The money for building the road has been provided, and the staff of engineers started from St. Petersburg early in March. These engineers will be carried from Odessa to Vladivostok on a Russian war-ship, and as the voyage will take about 40 days, the opening of the work was expected to take place early in May. The Engineer in charge of construction is Mr. A. Oursatti, who had charge of the preliminary surveys, and his chief assistant is Mr. T. Dox.

As material for construction is abundant along the line, the grading and other work will proceed rapidly. Several tunnels are required, but they will not be difficult of construction.

The actual commencement of work on this end of the Siberian Railroad will be made an occasion of considerable ceremony, and the Czarovitch will be present at the opening ceremonies.

Work will soon be begun on the line in Western Siberia, and arrangements are now being made for the preliminary works, construction of bridges, etc.

## PIRACY IN THE FRANKLIN INSTITUTE.

WE regret to be obliged to record that the venerable and dignified Franklin Institute has been the victim of unscrupulous imposition. The April number of its *Journal* of the Institute contains the first part of a paper on Riveted Joints in Boiler Shells, by William Barnet Le Van, which, its readers are informed, was "read at the stated meeting of the Institute, held November 19, 1890." It is our painful duty to announce that the greater portion of that part of the paper which is published in the April number of the *Journal*, including the engravings, was copied, without credit or quotation marks, or, in other words, was purloined from the *Railroad Gazette* of August 12, 1871, pages 222 and 223; January 13, 1872, pages 18 and 19; and February 10, 1872, pages 64 and 65, where it was published as editorial matter. The same articles were afterward republished in a little volume called "Coyne & Company's Railway Officials' Annual," issued by that firm in Chicago in 1872. The assumed author of the paper read before the Franklin Institute has published what he has copied from the editorial articles referred to, with very slight alterations, and has apparently embodied it in his paper, and read it to the Institute as his own production. This, it need hardly be said, is a grave offense. Mr. Le Van is an active member in the Institute. It will be interesting to learn what action it will take with reference to this delinquency of one of its own members.

## REMOVAL.

THE office of the RAILROAD AND ENGINEERING JOURNAL has been removed from No. 145 Broadway to the Stokes Building, No. 47 Cedar Street. To those with a limited acquaintance with localities in New York, it may be said that Cedar is the second street north of Wall, and runs parallel with it. The Stokes Building is a new office structure between Nassau and William streets, and is ten stories high. The office of the JOURNAL is on the eighth floor, and overlooks the East River, Brooklyn Bridge and city. A view from one of the windows of the new office is given on another page. Our patrons and friends are invited to call and bring one or more new subscribers with them.

## ENGLISH AND AMERICAN LOCOMOTIVES.

IN reverting to this subject again an explanation, or apology perhaps, is due to our esteemed contemporary, *The Engineer*, of London. On January 9 of this year it published an article with the following introduction:

> Several weeks have passed since, in response to a species of challenge published by the United States *Engineering News*, we published a detailed statement of the working expenses of the principal railways of Great Britain. Our contemporary maintains a prudent silence concerning these figures. Mr. Forney twits our contemporary, and announces that he must take up the cudgels himself for the American locomotive.

The copy of *The Engineer* referred to was received in this country while the writer was absent from home, and on his return his attention was not called to the article it contained until about two months after it appeared, and it was only at that late date that it was known to him that it had been written or published. That is the reason why no reference has been made to it in these pages until this late date.

Near the close of it the editor of *The Engineer* deposits a chip on his shoulder by saying that "probably Mr. F—— will have something to say in reply to this article." It seems desirable that a newspaper discussion of a subject like this should, as far as possible, be impersonal, but as *The Engineer* has seen proper not to be governed by that by-law of the journalistic code, it remains only to say that the editor of this paper does not propose to abandon his attitude of an independent commentator in this discussion.

In the sort of desultory skirmishing in which this JOURNAL has engaged during the somewhat quadrilateral discussion of the subject under consideration we have endeavored to assume an interrogative rather than an affirmative attitude. In other words, we have endeavored to be governed by a spirit of inquiry, and will try to ascertain, if possible, both the merits and demerits of the locomotives which are designed and built on this and on the other side of the Atlantic.

In the early stages of this discussion *Engineering News* —somewhat rashly, as we then thought—accepted a challenge from *The Engineer* "to explain precisely in what

VIEW FROM OFFICE WINDOW OF THE RAILROAD AND ENGINEERING JOURNAL.

way and how the American engine is a better all-round machine than its British contemporary." Seemingly it would be equally rash if *The Engineer* should undertake to "explain" the converse of this proposition.

It is very much as though a native of South America should argue with a citizen of this country that a mule is a better all-around beast of burden than an American horse. Such a discussion would probably be as inconclusive as that of the relative advantages of English and American locomotives has thus far been. To limit the arguments concerning the merits of mules and horses to the one question of the quantity of oats eaten by each per mile traveled in ascending the Andes and in running a race on a race-track in this country would obviously not be much of a guide to a person in Australia contemplating the importation of animals for drawing loads or for cavalry service. The discussion of such general and vague issues must necessarily be unconvincing, and that is one reason why we have jeered at our contemporaries. But it ought to be within the province of engineering papers in this country and in England to ascertain exactly and definitely some of the points of superiority and of inferiority of their respective engines, and to collect the evidence thereof and submit it so as to be more or less decisive with reference to the issues to which it relates. We have no intention of even attempting to prove that American locomotives are superior in all points to British engines, nor of admitting that the latter are in all respects better than the former. It surely implies a great degree of ignorance—or of prejudice—regarding the whole subject to say that either have not points of superiority or inferiority, but if by careful, candid and impartial discussion it can be shown exactly wherein English locomotives are better than ours, and the reason for it, to that extent will we be advantaged; and if, on the other hand, it can be demonstrated that our machines perform a given amount of service at less cost than their English contemporaries, to that extent will our brethren on the other side be benefited.

At the outset of such a discussion, it would be advantageous, perhaps, to paraphrase the question of the Catechism, and inquire: What is the chief end of a locomotive? The editor of *The Engineer* appears from the discussion to be of the opinion that the burning of the least quantity of coal per mile run is the paramount object to be attained by locomotives. Now, obviously—using the phraseology of the Catechism again—neither of these objects constitutes the "whole duty" of a locomotive. Such a machine is an instrumentality for hauling passengers and freight from one place to another, and its whole duty is to do this—under the conditions which may exist where it is used—at the *lowest possible total cost.* To show some of the conditions under which locomotives must work, the following quotations from letters recently received from locomotive superintendents are given. One of them writes:

I think it as well to draw your attention to the circumstances under which our road is operating, in case you are going to compare our performance with other roads not similarly situated. Our road is an expensive one in coal, as we are very far north, being blocked up with snow for about seven months in the year, the thermometer being frequently 30° to 40° *below* zero in some parts for weeks together; and you will understand that during the whole of these six or seven months we are fighting against snow and frost—our largest movement of freight being also usually in this inclement season. I need hardly draw your attention to the extra quantity of coal that must be used to make the necessary steam when the air is below zero for months, as it is with us, against a temperature, enjoyed by many roads in this country, of only a few days' frost in the year.

Another superintendent of motive power, whose road is not so far north, says:

Our last year's locomotive report is not very good, the circumstances being such as to make it show up very badly as regards repairs and consumption of fuel, wages, etc. The road was really overtaxed with business, and being a single track, the trains were laid out on side tracks, thereby taking an extra amount of time to make their trips, which caused an excessive consumption of fuel and increased pay to train men. In addition, this trouble caused many wrecks, which will account for the high rate of repairs. . . . . .

Of course you are perfectly familiar with the matter of roadway, as compared between the two countries, which is very detrimental to the American locomotive as regards the expenses.

Another one writes:

The fast growth of our mileage has necessitated the promotion of men to such an extent that the conditions surrounding the best results from our fuel are not fully up to the British standard, where to be a first-class fireman becomes an ambition; while here it is generally considered only a short probation, to be endured only as a stepping-stone to the other side of the engine, just keeping within the bounds of security of position.

The same writer says that there is great disparity in the quality of the coal used on his line, and that on one division the engines must use 14 different kinds, varying greatly in quality.

The superintendent of motive power and machinery of one of the longest lines in this country says:

Our locomotives have many obstacles to contend with that do not exist in Great Britain. One is, the bad quality of the water used in the boilers, causing heavy incrustation of lime and other matter, which is virtually a non-conductor of heat, and consequently demanding increased consumption of fuel in generating the steam. Our winters are, as a rule, very severe, although that of 1890 was comparatively mild; again, our house-room is very limited, and a large number of the engines are therefore obliged to remain out of-doors, on which account we burn perhaps fully three per cent. more of coal than we otherwise would. All these conditions conspire to augment the consumption of fuel materially. The bad water also has a most destructive effect upon our flues, aided by the poor coal we are supplied with, and we are in consequence constrained to remove the flues on an average of once a year. In England, as far as I have been able to learn, a welded flue in a locomotive is unknown, as the flues remain in the boilers intact from the time they are introduced until the boilers are scrapped.

I discovered the great superiority of the Welsh coal over the American product during my marine experience. I was engineer for eight years in the employ of the Cunard Line, running between New York and Liverpool.

Such are some of the conditions under which locomotives must work in this country and in some of the British colonies, and probably in other countries. The climate of Canada cannot be changed to suit its locomotives, the capital is often not available to put new roads in good condition, the morale of the men who can be employed cannot be altered suddenly to meet the requirements of roads built into new countries, nor can we afford to import coal to burn in our engines. Locomotives must be made to work in cold climates on poorly built and equipped lines; their management must be entrusted to men whose qualifications for their work are not equal to those which are available in England; they must burn coal varying greatly in quality and, in short, must work under conditions varying within very much wider limits than those which exist in an old and developed country like England. It is not said that the unfavorable conditions which have been enumerated exist on all American lines. But they do exist on many of them, and our locomotives must often

work under such circumstances. Now, it is folly to argue that our locomotives are inferior to those on English lines, because, under such unfavorable conditions, the former burn more coal than the latter do in their native land. As remarked before, the total cost of locomotive service in doing a given amount of work, under the conditions that may exist, is the only criterion of judging of their inferiority or superiority.

This total cost may be summed up under the following heads:

1. First cost and interest thereon.
2. Fuel consumption.
3. Engine service—that is, wages of locomotive runners and firemen.
4. Train service—that is, wages of conductors and brakemen.
5. Repairs.
6. Amount of service performed—that is, the number of miles run per year and the loads hauled.

The relative value of these items of expense will vary widely with the circumstances under which engines must work. Thus, if the performance of engines on the New York Elevated Railroads is compared with that of others in similar service, the comparison would not be effected by the cost of train or engine service, because each train is limited in size and must have a given number of guards and a locomotive runner and fireman. But on through freight or passenger service, on our main lines, these items become relatively of great importance, because their cost per ton or per passenger carried is reduced in an inverse proportion to the loads hauled, and no correct estimate can be made of the expense of locomotive service without taking these items into account.

As it seems doubtful whether any general comparison of English and American locomotives is likely to be either satisfactory or conclusive, we proposed, in a jocular way, during the progress of the discussion between *The Engineer* and *Engineering News*, that the editors should each design a locomotive, and publish and compare the designs. We now seriously propose to our foreign contemporary the publication of engravings in detail of one of the largest typical English express passenger locomotives, and also of one of the heaviest and most generally approved freight engines. When the total weight of these engines, in working order, without their tenders is announced we will prepare and publish similar engravings of American locomotives of an analogous type, and of as nearly the same total weight as are obtainable. Such illustrations will give actual examples of what is regarded as the best practice in the two countries, and with these examples before us and our readers comparisons of the construction and performance can be made to better advantage, probably, than is possible if the two races of locomotives are considered generically.

To the demand of *The Engineer* for data concerning the performance of American locomotives, similar to that which was "compiled from official sources" and published in its pages on November 7 of last year, it may be said here that, being heretofore only a commentator on the discussion, it was expected that the principals engaged therein would supply the evidence and the arguments. As one of the parties seems to have failed in contributing the data demanded by the other, it apparently falls to our lot to supply the deficiency. Before attempting to do this, it should be said that the compilation of such data as *The Engineer* has published is probably much easier in London than in New York. The British Board of Trade's statistics are available there, while here there is no similar organization or authority which collects such information. Many of the companies in this country do not keep any account of the fuel consumption of their locomotives; others, which keep such accounts, do not publish them. Few are kept on any uniform plan, and the only way to get such reports is by direct application to the locomotive superintendents of the different lines, who are not all either able or willing to supply them. The collection of such data as is obtainable, therefore, takes time. We have a considerable amount of material bearing upon this question, but we hope to get more. When the sources of expected supply are exhausted, a compilation will be made and submitted as evidence bearing upon the question at issue.

In the mean while, we feel quite sure that our readers will join us in the hope that our contemporary will comply with the request made in the early part of this article, and will give engravings in detail of a typical example of one of their heaviest express locomotives.

As this article has already exceeded the limits which it should occupy, only a few words can be devoted to *The Engineer's* editorial of January 9. In that it says:

> Mr. Forney takes exception in a singularly disingenuous way to a statement concerning the rate at which coal is burned in locomotive fire-boxes in this country. . . . . . He coolly pits the average performance of English engines against what we believe to be an exceptional performance.

It will be observed that our contemporary uses the ugly word "disingenuous." Readers of the JOURNAL can judge whether the imputation is a just one from the following evidence:

On September 5 *The Engineer* said: "The whole discussion turns on whether a locomotive boiler has to generate more steam in a given time in America than in England," and then made the statement that "careful experiment has shown that an average performance (of English locomotives) is 500 lbs. of steam per square foot of grate per hour."

Now, if this performance was "shown" by "careful experiment," it surely was not ascertained from the working of locomotives in ordinary use. The *average* evaporation of engines during experiments extending over a greater or less period or number of miles of service must have been at the rate of 500 lbs. of steam per square foot of grate per hour. In the October JOURNAL we reported that in some experiments made on the Grand Trunk Railway, consisting of nine runs of 250 miles each, the average consumption of coal was 121.6 lbs. of coal per square foot of grate per hour, and the average evaporation was 7.35 lbs. of water per pound of coal, or an evaporation of 893.7 lbs. of water per square foot of grate per hour. This *The Engineer* calls an "exceptional performance," although it was the average result of an engine in running 2,250 miles. The number of miles run during our contemporary's "careful experiment" is not given. Was it equal to 2,250 miles?

In the same number of the JOURNAL we gave the average results of experiments made on the Hudson River Railroad in running 9,438 miles, and showed that 739.12 lbs. of water per square foot of grate per hour were evaporated. Will *The Engineer* tell its readers whether this was "exceptional," and did the number of miles run in the "careful experiments" referred to exceed 9,438?

On September 19, in commenting on the trial of the

Vauclain compound engine, the editor of *The Engineer* said :

> The running time (of the Vauclain engine) was six hours, and in that time there was burned 16,389 lbs. of coal. As the grate was 25 sq. ft., a very simple calculation shows that the rate of combustion per square foot of grate per hour was over 109 lbs. We have nothing in England to equal this. About 75 lbs. per square foot of grate per hour may be regarded as *a maximum consumption* with our fastest and heaviest expresses.

In the August number of the JOURNAL it was shown that, *in tests of an hour's duration* on the 17-mile grade of the Baltimore & Ohio Railroad, 133.2, 148.1 and 193.7 lbs. of coal was burned per square foot per hour. Probably these rates of combustion are equalled nearly every day in the year on that part of the Baltimore & Ohio, and on some other railroads.

Our adversary says, " Mr. Forney coolly pits the *average* performance of English engines against what we believe to be an exceptional performance." By *The Engineer's* own admission this average was ascertained by " careful experiment," so it is not the result of every-day practice. We have also submitted the results of careful experiment. By its own admission the *maximum consumption* of their fastest and heaviest express engines is only 75 lbs. of coal per square foot per hour. We have shown that in ours the maximum is more than 2½ times as great.

We submit that the word " disingenuous" has been misused by our contemporary.

## NEEDED WATERWAYS.

FEW countries are better supplied with natural waterways than the United States, and it is to them and to the construction of some artificial ones that the country owes much of its earlier growth and prosperity. With the later great development of railroads, however, there has been a tendency to neglect the water routes, and they have not received the attention they should, although there have always been some advocates who appreciated their great economic value. It is not only as an actual carrier in comparison with the railroad that a waterway is to be estimated ; its value as a factor in competition and a regulator of rates is also to be taken into account. There is not space here, however, to support this statement by instances, the only purpose at present being to refer to one of the canal projects which have been brought before the public from time to time with varying success. Some have not, it is true, deserved success, but some, including this, certainly have a right to consideration.

The waterway which is most needed in the seaboard States is one which already exists in large part, and which needs only the building of a few comparatively short links to complete it. It is the line from Norfolk southward to Florida through the sounds and inland channels of the coast. This is already open from Norfolk nearly to the South Carolina line and from Charleston to Florida, while the gaps existing can be filled by canals easy of construction and presenting nowhere any considerable obstacles. The filling these gaps and the improvement of the existing channels would be works much less costly than many which have been undertaken and successfully carried out. Commercially it would be worth much more than it is likely to cost, while in case of a foreign war its value to the country would be almost inestimable. The ability to send ships of war on an inside line to any point on the coast would be an advantage which any strategist would recognize at once. No work of the kind can be found which is at once so feasible and offers so many advantages.

As a connection or extension of this line there may be mentioned the Florida ship canal, for which surveys were completed two years ago, and which is one of those works the postponement of which seems almost unaccountable. This is a more formidable undertaking, it is true ; but the difficulties are not by any means insurmountable. It is not any question of engineering, but only the lack of money which has so far delayed its construction.

With the Florida Canal added to the seaboard line, there would be an inland water route from New York to New Orleans which would soon become the highway for a great commerce, and might change in some degree the nature of the coasting trade. It would develop trade also and open up an outlet for much new business in lumber and other bulky freight which requires the cheapest transportation.

## THE PENNSYLVANIA SHIP CANAL.

REPORT OF THE SHIP CANAL COMMISSION OF PENNSYLVANIA. *Feasibility of a Ship Canal to Connect the Waters of Lake Erie and the Ohio River.* John A. Wood, W. S. Shallenberger, Eben Brewer, John M. Goodwin, Thomas P. Roberts, Commissioners.

The Canal Commission, to which the Pennsylvania Legislature intrusted the duty of examining the country between Lake Erie and the Ohio, with a view to taking action for the building of a ship canal to connect those waters, has prepared an exhaustive report, much of the excellence of which is evidently due to Messrs. Roberts and Goodwin, the two engineers of the Commission, both of whom are well qualified for the work.

Lack of space prevents us from doing full justice to this report, but a brief presentation of the conclusions reached will be of interest. After full examination and consideration, and in view of the peculiar nature and formation of the country on the border-line between Pennsylvania and Ohio, the Commission recommends the building of a canal partly within the latter State. The line adopted starts from Conneaut Harbor, on Lake Erie, and rises to the high plateau on the State line by a series of 25 locks in a distance of 12.37 miles, the summit level, 20 miles long, being 444 ft. above the lake. Two locks bring the line down to the Greenville level, 10.35 miles long, from which there is a gradual descent into the Shenango Valley, and thence to the Ohio at Rochester, the total descent to that point from the summit level being 310.7 ft., which it is proposed to make in 22 locks.

The canal, however, will not fulfil its purpose, in the opinion of the Commission, if it ends at Rochester, but should be continued parallel to the Ohio from Rochester to Pittsburgh Harbor. It is to Pittsburgh that a large part of its traffic must go, and unless vessels can reach that city directly they will not use the canal. The extension will require the excavation of 23.44 miles of canal, and the building of two locks at Davis Island.

The total length of the proposed canal is about 125 miles, including the extension to Pittsburgh Harbor. The cross-section proposed has a width of 100 ft. at bottom—slope of banks to be 1¾ to 1—a depth of 15 ft., and proper protection of banks. The locks would be large enough to pass vessels 300 ft. long, 44 ft. beam, and 14 ft. draft, which would include all the lake ore and grain carriers except those of the very largest class. The estimated cost is about $26 400,000.

The reasons given for the line chosen are comparatively low cost, directness of route, full supply of water, and the opportunity for extending local traffic on the line itself, and by canalizing the Mahoning River. The report gives these reasons in

full; and to appreciate them properly it should be carefully read.

## NEW PUBLICATIONS.

HANDBOOK FOR MECHANICAL ENGINEERS. By Henry Adams. Second Edition, revised and enlarged. (E. & F. N. Spon, London and New York.)

This book belongs to a class which is almost as difficult to review as a dictionary would be. It consists of a collection of notes which, as the author says, have been compiled from various sources.

The book begins by informing its readers that "motion is a change of place," and in the first chapter it is said that a force which, acting for unit of time, would impart unit velocity for unit mass is a *Gaussian unit*, and that the curve of quickest descent is a *brachystochrone*. The author seems to be of the opinion that by using hard names he is imparting knowledge.

The chapters or sections, as they are called, are on the following subjects: Fundamental Principles of Mechanics; Varieties and Properties of Materials; Strength of Materials and Structures; Pattern-making, Moulding and Founding; Forging, Welding and Riveting; Workshop, Tools and General Machinery; Power Transmission by Belts, Ropes, Chains and Gearing; Friction and Lubrication; Thermodynamics and Steam; Steam Boilers; The Steam Engine; Hydraulic Machinery; Electrical Engineering; Sundry Notes and Tables.

There is no good reason apparent for writing or publishing such a book. It requires no special ability; and to do it all that an ordinarily intelligent reader would need is to get the files of one or more good engineering journals, a few text and pocket-books, and then read and compile. The book before us has not the merits of a treatise, nor is it as useful as a pocket-book. It has no systematic plan; the material has been undigested, and the author has added an assumption of profundity by using hard names, Greek notation and mathematics, which will only be a puzzle to practical men.

I. IRRIGATION DEVELOPMENT. *History, Customs, Laws and Administrative Systems Relating to Irrigation and Water Courses in France, Italy and Spain.* By Wm. Ham. Hall, State Engineer. (Sacramento; State Printers.)

II. IRRIGATION IN CALIFORNIA. *The Field, Water Supply and Works in San Diego, San Bernardino and Los Angeles Counties.* By Wm. Ham. Hall, State Engineer. (Sacramento; State Printers.)

These two volumes together form a partial report on Irrigation, which was submitted by Mr. Hall, as State Engineer of California, two years ago, but which has only recently become available for general use, owing to the slow methods adopted with public documents.

Irrigation is comparatively so new a practice in the United States that the part on Italian, French and Spanish systems is really an essential and valuable feature of the report. While some of our methods are new, for all precedents and for experience we must go back to Southern Europe, India or Mexico—perhaps to China, where irrigation has been practised for many centuries, and where it probably originated.

Mr. Hall has given a very full account, with numerous illustrations, of what has already been done in the three southern counties of California, and of what was proposed at the time he wrote. Some of these projects have since been carried out, while others still remain in abeyance. The work has never been completed as originally proposed, owing to the failure of the Legislature to make proper appropriations; a neglect which is much to be regretted, as the later volumes would not only have completed the accounts of what has been done, but would also have treated of irrigation and water laws, and of other questions upon which action is much needed.

Even in its present unfinished state, however, Mr. Hall's report is a very valuable one, and contains much information that is not accessible elsewhere. It is accompanied by maps showing drainage area and rainfall distribution, and is printed in excellent shape.

## BOOKS RECEIVED.

*Annual Report of the City Engineer of Providence for the Year* 1890: *J. Herbert Shedd, City Engineer.* Providence, R. I.; printed for the City. A special feature of this report is an appendix, giving formulæ for ascertaining the loss of head due to the friction of water in smooth pipes, with tables worked out by the same.

*Improved Roads: An Address Delivered before the New Jersey State Board of Agriculture, by Chauncey B. Ripley, LL.D.*

*The Sioux City Bridge: A Report to Marvin Hughitt, President of the Sioux City Bridge Company, by George S. Morison, Chief Engineer.* Chicago. Some extracts from this excellent monograph will be found on another page.

*Reports of the Consuls of the United States to the Department of State: Nos.* 124, *January, and* 125, *February,* 1891. Washington; Government Printing Office.

*On the Maximum Steam Jacket Efficiency: by Professor Robert H. Thurston.* Philadelphia; reprinted from the *Journal* of the Franklin Institute.

*Examinations by the State Board of Health of the Water Supplies and Inland Waters of Massachusetts: Part I of Report on Water Supply and Sewerage.* Boston; State Printers. This volume reaches us too late to receive the full review which it deserves in the present number.

*Annali della Societa degli Ingegneri e degli Architetti Italiani: Anno V*, 1890. *Fascicolo VI.* Rome, Italy; published for the Society.

*Occasional Papers of the Institution of Civil Engineers.* London, England; published by the Institution. The present installment of these papers includes Indian Bridges, by F. E. Robertson and E. W. Stoney, and several shorter ones.

*Special Experiments with Cylinder and Journal Lubricants: by Professor J. E. Denton, Stevens Institute.* New York; reprinted from *Proceedings* of the American Society of Mechanical Engineers.

*Performance of* 75-*ton Refrigerating Machine of the Ammonia Compression Type: by Professor J. E. Denton, Stevens Institute.* New York; reprinted from *Proceedings* of the American Society of Mechanical Engineers.

*The Money Value of Solid Emery Wheels: by T. Dunkin Paret.* Reprinted from proceedings of the Association for the Advancement of Science.

*Emery Wheels: by T. Dunkin Paret.* Reprinted from the *Journal* of the Franklin Institute.

## TRADE CATALOGUES.

THE firm of Darling, Brown & Sharpe, of Providence, R. I., has issued a very handsome reproduction of the diploma awarded them at the Paris Exposition in 1889. It is artistic enough in appearance to be worth preservation.

The Westinghouse Machine Company has undertaken to advertise on a new plan, and has arranged a series of cards which will show in regular monthly succession the general character of the company's business; the leading points in favor of its engines; the points wherein they differ from other engines; the

different types made; the class of people by whom they are used, and other interesting points.

A trade catalogue of unique character is issued by the Joseph Dixon Crucible Company in the form of a package of pencils of various grades submitted for editorial consideration. No better recommendation could be found for these pencils than their constant use.

*Special Tools for Railway Repair Shops: Boring, Milling, Planing and Shaping Machines: Illustrated Catalogue of Pedrick & Ayer, Philadelphia.*

*Frontier Iron and Brass Works, Pulverizing and Separating Machinery, Detroit, Mich.*

*The Tanite Company, Catalogue of Solid Emery Wheels and Grinding Machines. Stroudsburg, Monroe County, Pa.*

*Berry Brothers' Varnish and Japan Works, Detroit, Mich. Illustrated Description.*

## ABOUT BOOKS AND PERIODICALS.

THE last quarterly number of the PROCEEDINGS of the United States Naval Institute opens with the prize essay for this year by Ensign A. P. Niblack, on Enlistment, Training and Organization of Crews for the New Ships. Other articles are on Siacci's Ballistic Equations, by Professor William Woolsey Johnson; on Target Practice, by Lieutenant J. F. Meigs; on Electric Revolution Counters, by Assistant-Engineer W. D. Weaver; and on an Experimental Ammunition Cart, by Lieutenant W. W. Kimball.

A hand-book of German technical terms has been under preparation for several years by Professor J. Howard Gore, of the Columbian University at Washington, and will soon be published by D. C. Heath & Company. Professor Gore has had especial facilities for compiling such a work, and it will be appreciated by all who have occasion to read technical German, and who know how deficient the ordinary dictionaries are in technical terms.

In HARPER'S WEEKLY the first of a series of illustrated articles on Australia has been published, and others are promised. The WEEKLY recently illustrated the "whale-back" steamer *Colgate Hoyt*, and the designs for the Columbian Exhibition buildings in Chicago, and gave a very entertaining article on Patents.

Among the new books in preparation by John Wiley & Sons, New York, are the Mechanical Engineers' Pocket Book, by William Kent, and the Transition Curve Field Book, by Conway R. Howard. An inspection of the material of Mr. Howard's book enables us to say that it will be an excellent one for its purpose, and a very convenient assistant for engineers on railroad work.

In HARPER'S MAGAZINE for May the series of South American articles will be continued by one on Uruguay, by Theodore Child, and another on the Argentine People, by Bishop J. M. Walden. Colonel T. A. Dodge begins a series of short papers on Horsemanship in America. The lighter articles include several of special interest.

Among the articles in the POPULAR SCIENCE MONTHLY for April there may be mentioned the History of the Ohio River, by Professor J. F. James; Street Cleaning in Large Cities, by General Emmons Clark; What Keeps the Bicycler Upright? by C. D. Warring, and Changes in California, by C. H. Shinn. In the May number there will be an illustrated article on Ice Making and Artificial Refrigeration, by F. A. Fernald, describing a growing and important industry.

Two articles in BELFORD'S MAGAZINE, for April, on University Training, written from diametrically opposite points of view, will attract much attention. The Silver Question and Protection are also discussed in this number. While keeping up its controversial character, however, the purely literary side has not been neglected, and plenty of light reading is provided.

The National Guard of Wisconsin is the subject of the military article in OUTING for April; it is written by Captain Charles King. Composite Photography, Canoeing in the Chambly Rapids, and Esquimaux Whaling are among the other articles. In this number Captain Schuyler's paper on the Evolution of Yachting is concluded.

In SCRIBNER'S MAGAZINE for April the first of the promised series on Ocean Passenger Travel is published; it is general and historical in its nature, and has many illustrations. The Cruise of the United States Steamer *Thetis* in the Arctic is described and illustrated. An article on Right-Handedness, by Dr. Thomas Dwight, deserves a careful reading. The article in the steamship series in the May number is on the Ship's Company, and is by Lieutenant J. D. J. Kelly, U. S. N. In this number also is a paper on Broadway, by Richard Harding Davis, which is the first of a series on the Great Streets of the World.

We are requested to state that Mr. Robert Grimshaw, General Editor of the Trades Department of Funk & Wagnalls' Standard Dictionary, being desirous of making as complete as possible his list of mechanical and industrial terms, requests manufacturers of machinery and tools having important parts not found on those of other makers, or the names of which are not yet in general use, to send the name, definition and use of each such part to him at 115 Bible House, New York City.

## THE DISCOMFORTS OF RAILROAD TRAVEL.

*To the Editor of the Railroad and Engineering Journal:*

I HAVE read with interest the article, "The Discomforts of Railroad Travel," published in your issue of February. May I ask you to request the gentleman who wrote the article to kindly blister the uniformed idiot who opens the front door of your car a quarter of a mile before the next station is reached, bawls out the supposed name of the station, leaves the door fastened open, goes to the rear door of the preceding car, and again emits a bawl. When the train stops he helps off all the younger females, lets the old ones shift for themselves, returns to the car in front, and advises the passengers that the "Nexstaishiz yaup—yaup," and then conveys the same important information to you, and then, and not until then, does he close the door of your car.

Another fiend deserves his attention; he is the engineer who might be termed a "yanker."

On reading the notices of the railroad that furnishes "The finest service in the world" (please note that this applies to any and all roads), you will find one which reads something after this manner: "Passengers taking the — P.M. train, which will arrive at Blankville at — A.M., may remain in their berths until 7 o'clock." Would that the scribe who wrote these lines, and the railroad official who dictated them, would take passage in one of these trains. He will find that when he arrives in the suburbs of Blankville that he will be rudely awakened by the detaching of his car from the train, it will be jerked this way and bumped that way without any apparent reason. At last he despairs of getting further sleep, and resolves that he will dress and leave the car. About the time he has finished dressing he will notice that the car has at last found a resting-place; but, as he has resolved to go, he goes, and, arriving at the door, finds that his car is on a siding, and upon inquiry of the porter, who by this time is sufficiently awake to make a few passes through the air with his whisk and hold his hand for the hoped-for quarter, that the depot is "right down that there track, sir, about two blocks and a half."

After walking down "that there track," dodging several freight trains, he finds the depot, and mentally and explosively resolves that the next time he takes a train in which "the passengers may remain until 7 o'clock," it will be when all the other places are closed and the walking is bad.

A. SPIKE.

## A NEW SPANISH CRUISER.

THE accompanying illustration, which is taken from London *Engineering*, shows the first-class armored cruiser *Pelayo*, recently completed for the Spanish Navy by the Compagnie des Forges et Chantiers at the yards at La Seyne, near Toulon. The plans for the hull of the ship were prepared by M. Lagane, Director of the Works, and the engines were designed by M. Orsel.

The dimensions of the ship are as follows: Extreme length, 346 ft. 6 in.; width at water-line, 66 ft. 3 in.; draft of water aft, 24 ft. 9 in.; displacement, 9,900 tons. The ship is constructed of steel throughout, and is protected by a water-line belt of armor 6 ft. 10 in width, extending the whole length of the hull, and varying in thickness from 17.7 in. in the center to 11.8 in. at the ends. Above this belt the protection consists of a steel deck placed at the level of the top of the plates.

The ship has a double bottom divided into 98 water-tight cells, while the space between the bottom and the armored deck is separated into compartments by 16 transverse bulkheads and by several longitudinal bulkheads, making no fewer than 145 compartments. All of these divisions, including those in the double bottom, can be emptied by means of a collecting channel 12 in. in diameter running from end to end of the ship, and connecting with two large pumps. There are other pumps also which can be employed in addition for draining any of the compartments. The coal-bunkers are so arranged as to give additional protection to the engine and boilers.

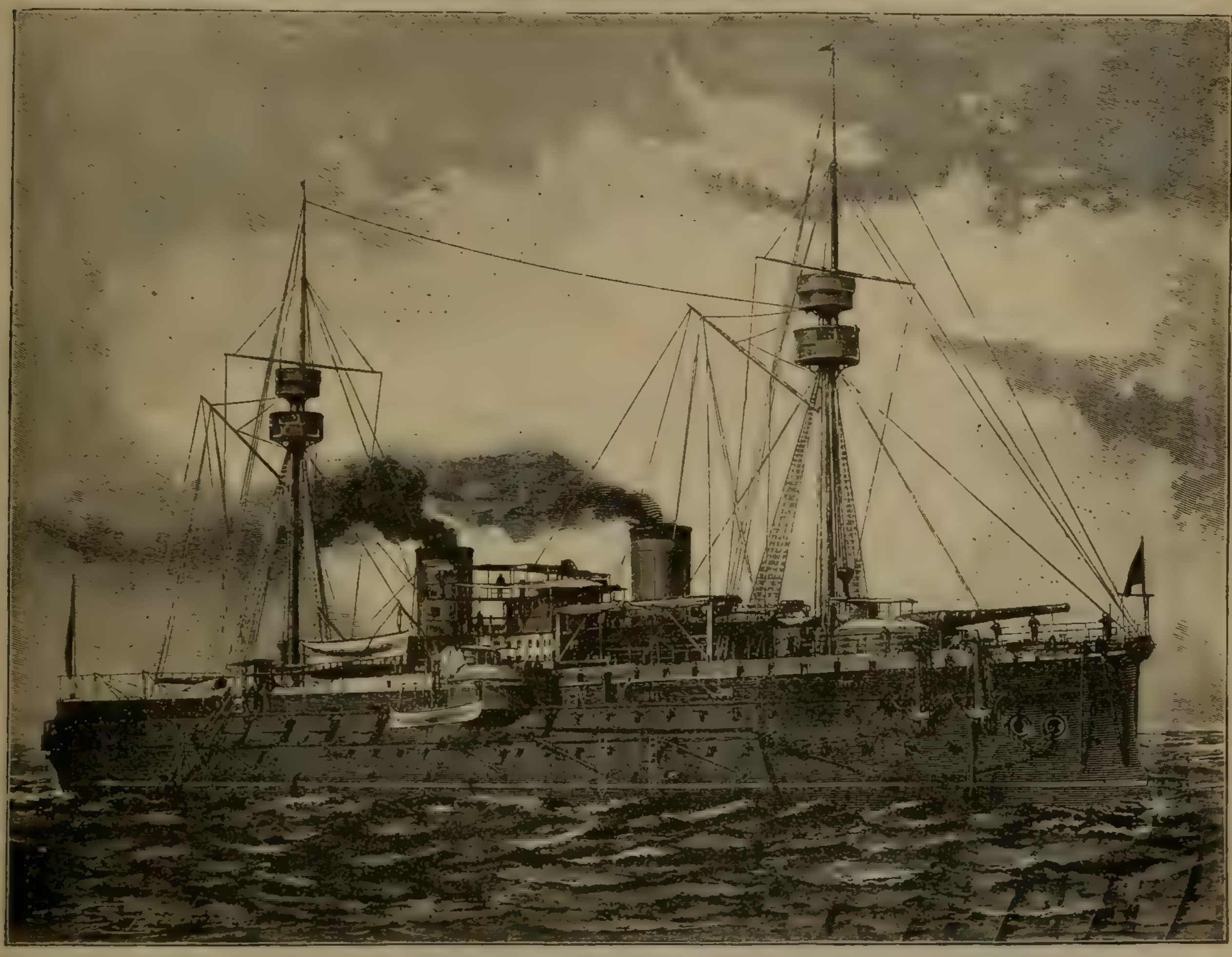
The quarters for the officers and crew are ample, and are arranged on the upper decks above the armored decks. The magazines for ammunition are in three groups arranged for convenient supply of the guns.

For ramming purposes the ship carries a heavy steel spur forward, which forms part of the framing of the vessel.

The armament consists of two 32-cm. (12.6-in.) Hontoria guns mounted, one forward and the other aft, in two barbette turrets; two 28-cm. (11-in.) Hontoria guns placed almost amidship, one on each side; one 16-cm. (6.29-in.) Hontoria gun placed well forward; twelve 12-cm. (4.72-in.) Hontoria guns placed six on each side in batteries. The secondary battery consists of a number of rapid-fire and revolving guns carried on deck and in the double tops of the military masts. There are also seven torpedo tubes carried on the lower deck.

The barbette turrets in which the 32-cm. guns are placed are protected by steel plates 13.8 in. thick, and the turrets are supported on a framing also protected by steel plates 7.9 in. thick, extending down to the armored deck, and serving as a cover for the ammunition hoists. The forward turret is placed at a height which brings the axis of the gun 31 ft. above the water-line; it has a firing angle of 250°. The rear gun has the same elevation, and a firing angle of 220°. The 28-cm. broadside guns have each a firing angle of 180°, so that they can be used either in chasing or retreating, and three heavy guns will always be available in each direction. A heavily armored shelter on the upper deck is fitted up with electric and other signal apparatus and steering gear, so that the Captain can direct the fighting of the ship in security.

The *Pelayo* has two screws, each driven by an independent compound engine, and steam is furnished by 12 return-flue boilers built for a working pressure of 80 lbs.



ARMORED CRUISER "PELAYO," FOR THE SPANISH NAVY.

The usual number of auxiliary engines, pumps, etc., are provided.

On the trial trip the ship reached a speed of 16.2 knots an hour with natural draft. The capacity of the coal-bunkers is 800 tons, which will give a cruising radius of 5,000 miles at a 12-knot speed, and of 7,500 at a 10-knot speed.

The *Pelayo* is much of the same class as the *Maine* and *New York*, now under construction for our own Navy, although she has a somewhat greater displacement.

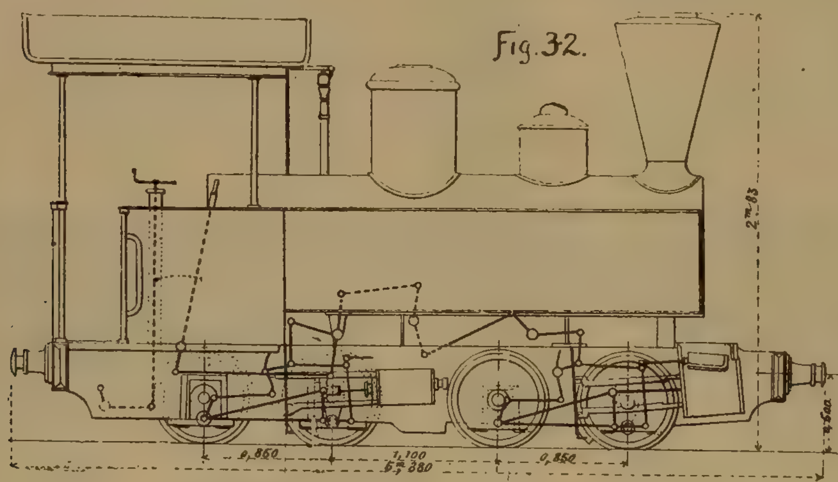


Fig. 32.

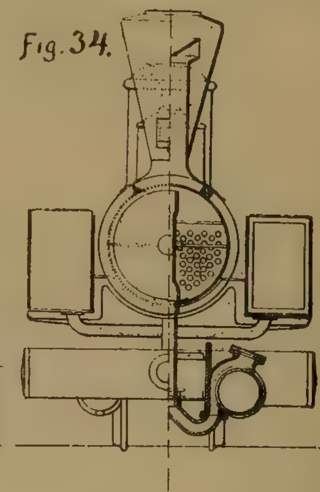


Fig. 34.

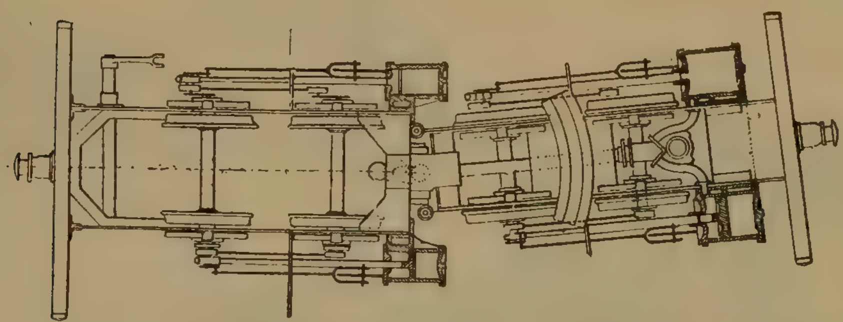


Fig. 33

ARTICULATED COMPOUND LOCOMOTIVE, DECAUVILLE SYSTEM.

## THE DEVELOPMENT OF THE COMPOUND SYSTEM IN LOCOMOTIVES.

By M. A. Mallet.

(Paper read before the Société des Ingenieurs Civils, Paris; translated from the French by Frederick Hobart.)

(*Continued from page* 158.)

### FOUR-CYLINDER LOCOMOTIVES WITH FOUR MOTIONS.

I must here once more refer to my paper of 1877, in which I spoke of "four cylinders, two high-pressure and two low-pressure, each of these having its own valve motion. These four cylinders can act upon the same axle, and then by connecting the two cylinders of the same group on crank-pins placed at an angle of 180°, we can realize very satisfactory conditions of balance for the driving-axle, as Randolph and Elder have already done for marine engines. We can also make each group of cylinders act upon a different axle, whether these axles are coupled or not. In this last case we would have a Meyer or Fairlie compound engine, which would be a very good arrangement, because the complication would be justified both by the very principle of the engine—flexibility—and by the better working of a compound than a simple engine."

The Dawes patent showed both these arrangements, the engine working on cranks 180° apart and the division into two separate groups not coupled together, but without the articulation of these groups; that is to say, their placing on separate trucks. Up to the present time the form of four-cylinder engines with cranks at 180° has only been carried out once to my knowledge. The arrangement in two separate groups which has been made in other cases has been without coupling.

This second plan presents, again, two cases, that in which the two groups of driving-wheels are carried on one rigid frame and that where each has its own frame, these frames forming trucks which can assume a different relation to each other in passing around curves.

The only example of which I have knowledge of the arrangement of four cylinders with cranks at 180° for one group, the second group having its crank-pins at 90° with those of the first, is the engine *Vulcan* of the Scinde, Punjab & Delhi Railroad, which had high-pressure cylinders inside, 16 in. in diameter, each of which was replaced by one cylinder 17 in. in diameter in the same position as the old one, and an outside cylinder 12 in. in drameter working on a crank-pin placed on the driving-wheel at an angle of 180° with the inside crank. The stroke of the pistons was 24 in.; the diameter of the main driving-wheels and of the rear coupled wheels was 60 in. This change was made in 1884, and good results were obtained from the engine both in economy and increase of power; but I have never heard that this model has been reproduced.

An example of the type with two groups not coupled and on a single frame is given by locomotive No. 701 of the Northern Railroad of France, built by the Société Alsacienne, on the plans of M. de Glehn, No. 38 in the large table. This machine has been described, and it may be considered an excellent model, the only point to be regretted being that the large cylinders were not made greater in diameter. They should have been increased so as to give a ratio with the high-pressure cylinder of 1 : 2.30, which would have been preferable with a pressure

of 160 lbs. This is the only application so far made of this arrangement, which we must consider as much superior to that of Mr. Webb.

The form with four cylinders in two groups acting upon different axles, the axles being coupled together, has been carried out on the Paris, Lyons & Mediterranean Railroad on three types of locomotives—Nos. 47, 48 and 49 in the table—two of which were shown at the Exposition of 1889. This type has been described minutely in several papers.

The object proposed in these engines is to obtain great regularity in the moments of rotation; but this advantage, obtained by carefully studied combinations, has unfortunately been realized only at the cost of considerable complication.

The last arrangement of this class, which places two groups on independent frames or trucks, is that type of four-cylinder locomotive which has, so far, had the greatest number of examples. This system was worked out in 1877 and presented in 1884 under its present form. It was carried into practice in 1887, thanks to the intelligent co-operation of M. Paul Decauville, who readily comprehended the advantage of using on his system of railroad a type of locomotive combining great power, flexibility and the division of the load over a number of bearing points.

A common mistake which has been made in describing this machine is of representing it as carried upon two trucks. In reality there is only one truck forward, which is joined to the fixed part of the engine by the center-bearing and levers. The latter is composed of the boiler, the water-tanks and the frame, carried upon the wheels of the rear group, to which the high-pressure cylinders are attached, while the low-pressure cylinders are fixed upon the forward truck. The advantage of this arrangement is that the high-pressure steam-pipe is fixed as in an ordinary locomotive, and that the only joints required are in the steam-pipe connecting the two groups of cylinders, which carry steam at a pressure of not over 60 lbs., and in the exhaust pipe.

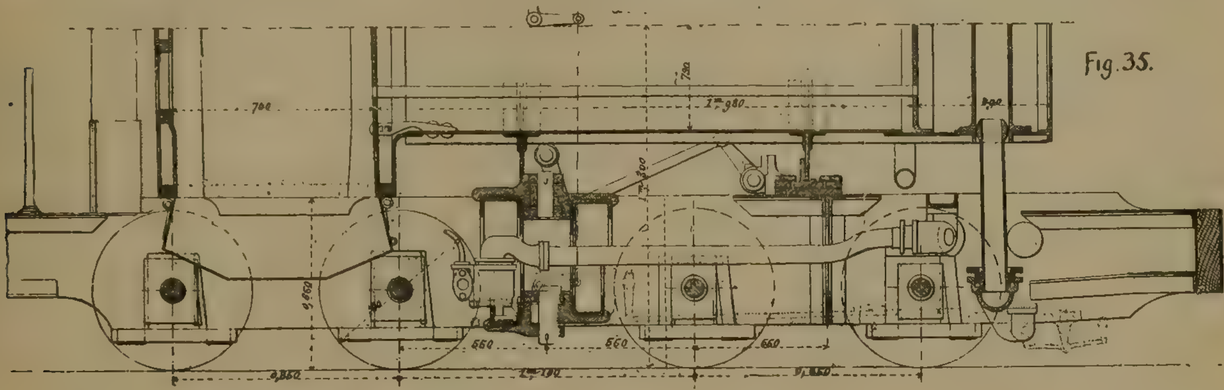


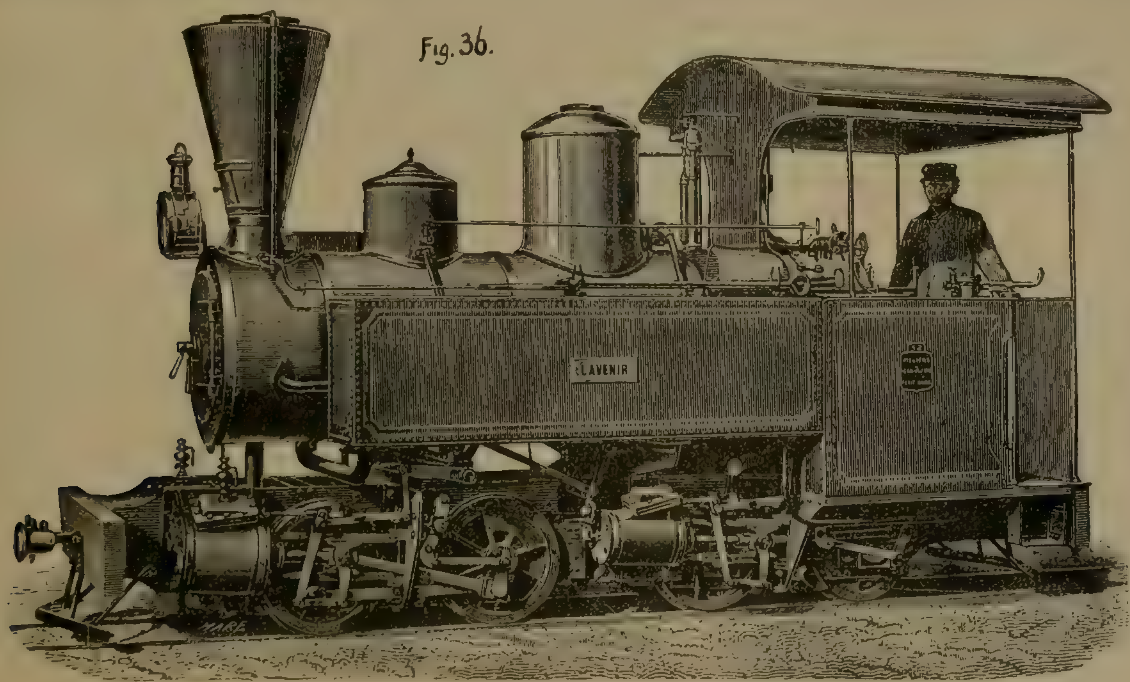
Fig. 35.

STEAM PIPE CONNECTIONS, ARTICULATED COMPOUND LOCOMOTIVE.

It may perhaps be useful to mention the conditions which govern the design of this type of engine. They were that the engine must carry, on a track of 24-in. gauge, a load of 8 or 9 tons on grades as high as 8 per cent.; that it must pass around curves of 66 ft. radius, and that the weight must not exceed 3 tons on each axle, or 1½ tons on each wheel. The first condition required the use of an engine weighing about 12 tons, while the third required the use of four axles, and the second made it impossible to couple these four axles together, and rendered the division of the machine into two groups necessary. Both the Fairlie and Meyer type fulfilled these conditions; but I must be permitted to consider my own as much more simple and economical in working, and I think that practice has made this very clear.

There have already been built over 30 locomotives of

Fig. 36.



ARTICULATED COMPOUND LOCOMOTIVE, DECAUVILLE SYSTEM.

this type for gauges varying from 24 to 31½ in. The best known application was that made in the Decauville Railroad at the Exposition of 1889.

Some engines of the same system have been built for roads of one meter gauge. They worked on a line of the Departmental Railroad Company and on the Durango-Zumarraga Railroad, where there are grades of 2.5 per cent., combined with curves of 328 ft. radius on the first-named line and of 236 ft. radius on the latter. The engines of the Departmental Railroad are included in the table, No. 41. On these roads the fact has been recognized that a compound engine weighing 24 tons in working order would haul 50 per cent. more load than an ordinary engine weighing about 22 tons, with three coupled axles and a leading axle, the heating surface being about the same in each case. The saving per ton per kilometer on the Montereau-Souppes line for a period of seven months was about 20 per cent. in fuel for the compound engine. These results are shown in the table given herewith, which shows the amount of fuel burned by the articulated compound engine and by four ordinary engines having three coupled axles and a bearing axle in the rear for a period of seven months—from October 1st, 1888, to April 30th, 1889.

| Oct. 1, 1888—April 30, 1889. | Compound Locomotives. | Ordinary Locomotives. |
|---|---|---|
| Total distance run | 22,222 km. | 42,587 km. |
| Tons hauled one kilometer | 854,200 | 1,414,500 |
| Total consumption of fuel | 153,868 kg. | 317,957 kg |
| Fuel burned per kilometer run | 6.920 " | 7.460 " |
| Fuel burned per ton hauled 1 kilometer | 0.180 " | 0.225 " |
| Saving per kilometer run | 7.24 per cent. | ............... |
| Saving per ton hauled 1 kilometer | 19.92 " " | ............... |

Note.—The consumption of fuel is equivalent to 0.5796 lbs. per ton-mile for the compound and 0.7245 lbs. for the ordinary locomotive.

When the limit of the load of the ordinary locomotives is passed, which often occurs on this line during the season of the beet crop, the saving in fuel by the compound increases to as much as 35 per cent. We are speaking here of the actual commercial economy, the consumption of fuel reported including everything—lighting fires, switching, stations, etc. On this basis we cannot report exactly the economy due to the coupound engine, which is evidently greater than that reported. On the other hand, all of this economy is not due to the compound working, because the machine is more powerful and draws a heavier load, but as it is not sensibly heavier than the other and as the double expansion here has allowed us to make this arrangement in a practical manner, at the same time really simplifying the engine, I believe that the entire saving can justly be credited to the compound.

For standard gauge I might mention the 35-ton engines in service on the Herault Railroad, shown in figs. 39 and 40—No. 43 in the table; the powerful 56-ton engines for the Central Swiss Railroad, shown in figs. 37 and 38—No. 44 in the table—both of these types having four axles; and a very heavy engine of 85 tons for the Gothard Railroad, figs. 41 and 42—No. 45 in the table—the last named having six axles. This is much the heaviest engine now existing in Europe, and has only been exceeded on this continent by some Fairlie engines recently built in England, and intended for a Mexican railroad.*

The large compound articulated locomotives for the Central Swiss Railroad were built by Maffei at Munich, and it is interesting to remember that these same shops in 1841 received a prize for their engine *Bavaria* in the famous competition for the Sömmering Railroad. These shops are to-day building the engines of which we speak, and which resemble much more the types of two of their old-time rivals, the Seraing and the Wiener-Neustadt Shops, than of their own former model. It is true that 40 years have passed since then. The Engerth locomotive, for instance, at the Sömmering competition had a very considerable success, but to-day it is not even mentioned.

In the accompanying table we give the principal dimensions of the different types of locomotives which we have mentioned, regretting that we cannot add to them at the present time the dimensions of an order recently received by Maffei for a locomotive of one meter gauge for the Landquart-Davos Railroad. These engines will have four axles, will weigh about 36 tons in working order, and will be able to haul 80 tons on grades of 4½ per cent.

To sum up, the compound articulated engine has obtained in practice a success which insures rapid development. The first engine was put under construction in the spring of 1887, and there are now over 50 of different dimensions and of different gauges in service or under construction. The adoption of this type for very powerful engines on important lines is a remarkable fact, and I hope soon to be able to present the results obtained in practice with the more recent applications—that is, the larger engines.

Before quitting this subject, however, I would like to emphasize the point that if in the construction of this type we have been guided by considerations foreign to the question of economy in fuel, this last advantage has been naturally added, since the double expansion, which was not the main point, has led to a considerable simplification in the arrangement of the steam-pipes. This is the case where, in spite of the adversaries of the system, the compound engine, which they represent as complicated, is really the opposite and does away with complication in certain delicate parts of the locomotive.

This might be the place to say something of the starting arrangements and of the valve gear used on compound engines of three or four cylinders, as we have already

| | No. 1. Figs. 32–36. | No. 2. Fig. 43. | No. 3. Figs. 39–40. | No. 4. Figs. 37–38. | No. 5. Figs. 41–42. |
|---|---|---|---|---|---|
| Lines where engines are in use | Decauville. | Departmental. | Herault. | Central Swiss. | Gothard. |
| Builder of engines | Decauville Co. | Belfort Co. | Cail. | Maffei. | Maffei. |
| Gauge of road | 2 ft. to 2 ft. 7⅛ in. | 1 meter. | 4 ft. 8½ in. | 4 ft. 8½ in. | 4 ft. 8½ in. |
| Grate surface | 5.17 sq. ft. | 8.40 sq. ft. | 15 57 sq. ft. | 19.38 sq. ft. | 23.68 sq. ft. |
| Heating surface, fire-box | 24.76 " " | 45.07 " " | 69.97 " " | 86.11 " " | 100.11 " " |
| " " tubes | 215.29 " " | 306.03 " " | 753.50 " " | 1,259.42 " " | 1,560.82 " " |
| " " total | 240.05 " " | 351.10 " " | 823.47 " " | 1,345.53 " " | 1,660.93 " " |
| Working pressure of boiler | 170 lbs. | 170 lbs. | 170 lbs. | 170 lbs. | 170 lbs. |
| Diameter of high-pressure cylinder | 7.36 in. | 9.84 in. | 12.00 in. | 13.98 in. | 15.75 in. |
| " " low-pressure " | 11.02 " | 14.96 " | 18.11 " | 21.65 " | 22.83 " |
| Stroke of all cylinders | 10.24 " | 18.11 " | 20.47 " | 25.20 " | 25.20 " |
| Diameter of driving-wheels | 23.62 " | 35 43 " | 47.24 " | 55.12 " | 48.79 " |
| Distance between axles in each group | 2.79 ft. | 3.77 ft. | 4.76 ft. | 6.23 ft. | 8.86 ft. |
| Total wheel-base | 9.18 " | 13.12 " | 16.40 " | 20.33 " | 26.67 " |
| Capacity of water-tanks | 370 gals. | 793 gals. | 1,116 gals. | 1,321 gals. | 1,850 gals. |
| Weight of engine empty | 20,500 lbs. | 41,900 lbs. | 61,700 lbs. | 106,000 lbs. | 145,500 lbs. |
| Weight in working order | 25,800 " | 54,000 " | 77,100 " | 130,000 " | 187,400 " |
| Tractive effort at rim of wheel | 3,968 " | 8,375 " | 10,379 " | 15,208 " | 22,040 " |
| Minimum radius of curve on which engine will work | 59 ft. | 148 ft. | 263 ft. | 328 ft. | 492 ft. |

* These engines are exceeded in weight by the locomotives for the St. Clair Tunnel, lately completed at the Baldwin Works.

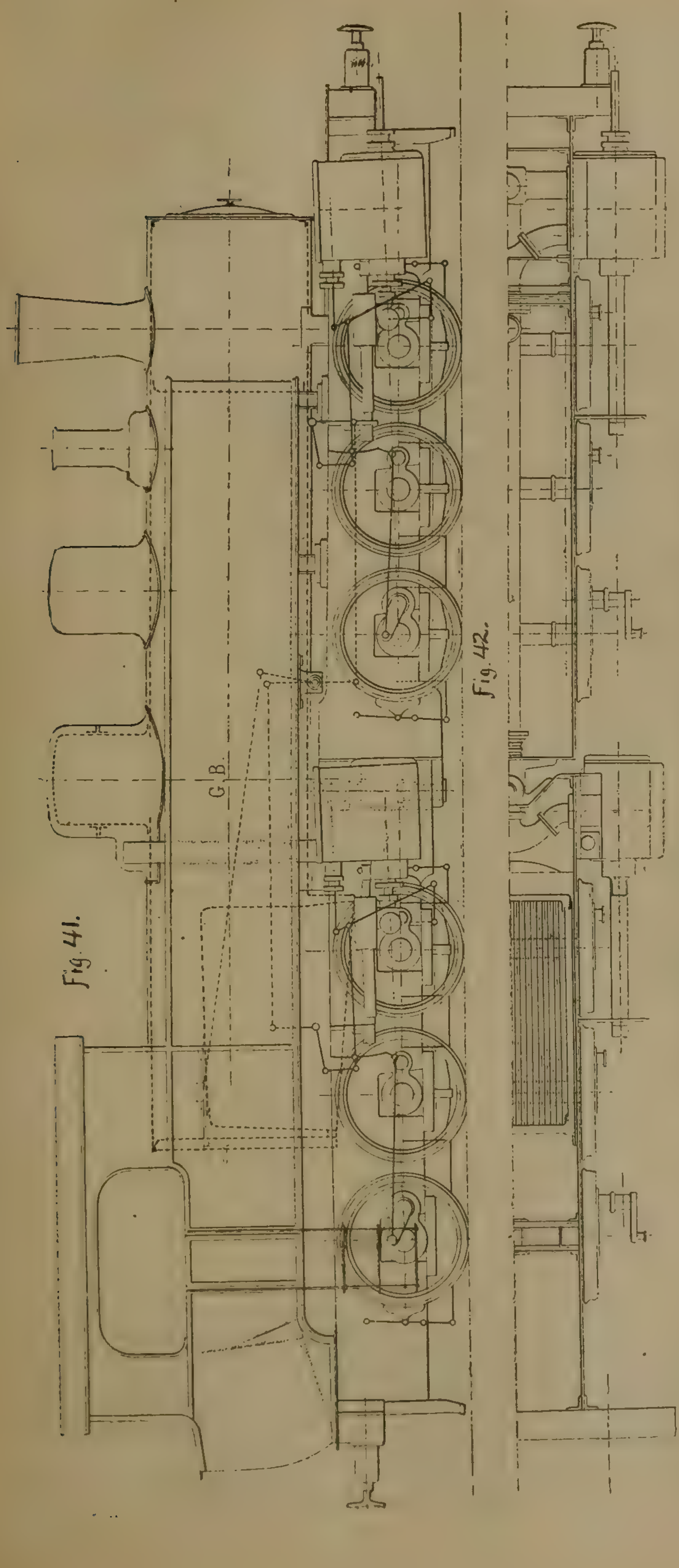



Fig. 41. Fig. 42.

FOUR-CYLINDER COMPOUND LOCOMOTIVE, GOTHARD RAILROAD.

spoken of those parts of the two-cylinder engines. The question of starting has less importance for the first, and it has generally been considered sufficient to put in a valve permitting direct steam from the boiler to be used in starting; a safety-valve or reducing valve limits the pressure, which can thus be made one-half the boiler pressure. In some of the Decauville engines I have placed a starting valve, which allows both groups of cylinders to be worked as ordinary engines in case of necessity. In the heavy engine on the Gothard Railroad a similar apparatus has been put in, so that the engine can, when required, start heavy trains on the long grades of 2.6 per cent.

We have seen above that Mr. Webb had recently proposed to use an arrangement of this kind on his engines; but this arrangement would only be justified by coupling the two groups of driving-wheels.

In the Baldwin engine the high-pressure cylinders carry a steam-pipe which joins their two extremities and a valve which, when opened at starting, admits the steam from the boiler through the small cylinders to act upon the large pistons, which only work in starting. It is possible that this arrangement has been a second thought, for it does not appear to us to conform very well with the method of connecting the two cylinders of each pair.

In compound engines with three or four cylinders, all the systems of valve gear used on the two-cylinder engine can be applied, and we shall not insist upon this point. We may say, however, that several engineers, Mr. Webb among others, think that it would be sufficient to give the low-pressure cylinders a fixed opening equivalent to 50 or 60 per cent. of the stroke, which would make it possible to use a single eccentric for each cylinder. This arrangement has been used on the locomotive *Jeanie Deans*, of the London & Northwestern. It is evident that in this case we must give up the use of the low-pressure cylinders in starting, and it remains to be seen whether the use of a single eccentric is good practice on a locomotive. This system, however, has been used for the low-pressure cylinder of the compound engine of the steamboat *Hirondelle*, running on the Seine; this engine is run at 180 revolutions per minute.

In our compound articulated engines there is a special arrangement for connecting the reversing shafts of the two groups which are not parallel on curves. On curves of a very small radius, where consequently the axes of the two groups make a sharp angle, sometimes 6° and more, in the Decauville engine there is a shaft carrying in the center a universal joint, of which the left-hand part is coupled by a link with the forward reversing shaft, while the right-hand part is in the same

way coupled by a link with the reversing shaft of the rear group, and receives by another link the motion of the reversing lever. In the other engines, where the angle of the axes is much less, the reversing shafts of the two groups are joined by a link placed in the longitudinal axis of the engine, the ends of which are attached by a double joint to the levers of those shafts. This is an arrangement similar to that adopted in the Fairlie engines.

It is well to remark that for the distribution of steam in four-cylinder engines having two groups not coupled together, we must take account, as in the Webb engines, of a consideration which does not exist in other types, or at least in the same degree. This is the necessity of making for the maximum work the power exerted by each group of cylinders proportional to the adhesive weight upon the corresponding wheels, in order to utilize in the best way the weight of the machine.

In engines with three or four cylinders the pipes connecting the high and low-pressure cylinders are carried through the smoke-box or not, according to the general arrangement of the engine. Sometimes a distinct steam-pipe for each pair of cylinders is used.

In the articulated engines there is only a single connecting pipe, into which the two high-pressure cylinders discharge, and which leads to the low-pressure cylinders. What we have said of this connecting-pipe for two-cylinder engines can be applied as well to those of three or four cylinders; and it is hardly necessary to say that whatever may be the arrangement adopted, it is necessary to protect these pipes against cold wherever they come in contact with the exterior air.

In the accompanying illustrations, figs. 32, 33 and 34 are outline views, showing respectively a side elevation, a plan of the running gear and a front view and section through the smoke-box of one of the Decauville engines; fig. 35 is a longitudinal section on an enlarged scale, showing the steam-pipe connections, while fig. 36 is a perspective view of the same engine. This engine was one of those shown at the Exposition of 1889. Figs. 37 and 38 show the Central Swiss engine referred to above; figs. 39 and 40 the 35-ton engine for the Herault Railroad and figs. 41 and 42 the heavy 85-ton engine for the Gothard Railroad; fig. 43 shows one of the engines built for the Departmental Railroad, which is referred to above.

Having thus completed a summary review of the different types of compound locomotives so far built, we can submit a question: Is it necessary, or, rather, is it possible to derive from this examination any conclusion in favor of the superiority of one or other of these types? Is it possible that a definite general form will be established? Such a selection will justify those engineers who now say that they are waiting to apply the compound principle when practice shall have revealed such a distinct type by a process of selection from the models actually in use.

I do not believe it!

More than half a century of operation of railroads has not succeeded in securing the general adoption of one position for the cylinders of locomotives, and many years of practice have not established the superiority of one system of valve gear. It is the same with many other points; and each engineer of motive power continues to build his locomotives according to his personal tastes and preferences, without endeavoring to make them resemble those of his colleagues. It will probably be the same for the different types of compound locomotives. All, or at least almost all, of the forms find their justification in certain cases. At the same time we may suppose that the two-cylinder type, which was the first, and which has made the greatest actual advance, thanks to its comparative simplicity in construction and maintenance, will preserve that advance, since it can be applied, as we have already seen, to almost every case met with in actual railroad practice. The type with four cylinders placed in two separate groups for fast engines, or in tandem for heavy freight engines, will be preferred by those who attach importance to the objection raised to the want of symmetry of the two cylinders. Finally, the articulated engines have before them a wide field for lines of sharp curves and heavy grades; the secondary lines for which there is now a great demand.

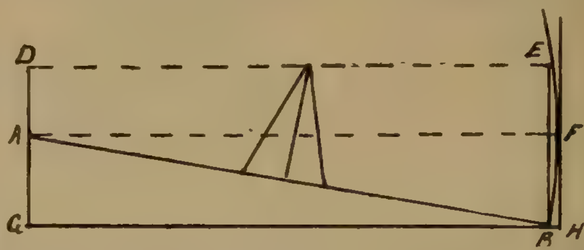
I do not believe that the future will change this view. It is, moreover, as I have said above, almost exactly that of the American engineers, whose opinion is worth careful consideration, not only because of their judgment and acute character, but also because for them the compound locomotive is a new field, and is free from all questions of *amour-propre* and personal interest, and they are thus placed in a position for disinterested and independent judgment.

(TO BE CONTINUED.)

## PRECISE HORIZONTAL MEASUREMENT ON SIDE-HILLS.

By Seth Pratt, C.E.

Let *A B* represent one or more chains. Set the instrument between *A* and *B*. Take the heights *A D* and *B E*. The *difference* of these heights divided by the number of chains in *A B* will give the difference in height for one chain. The accompanying table will show the allowance to be made for *one* chain, which being multiplied by the



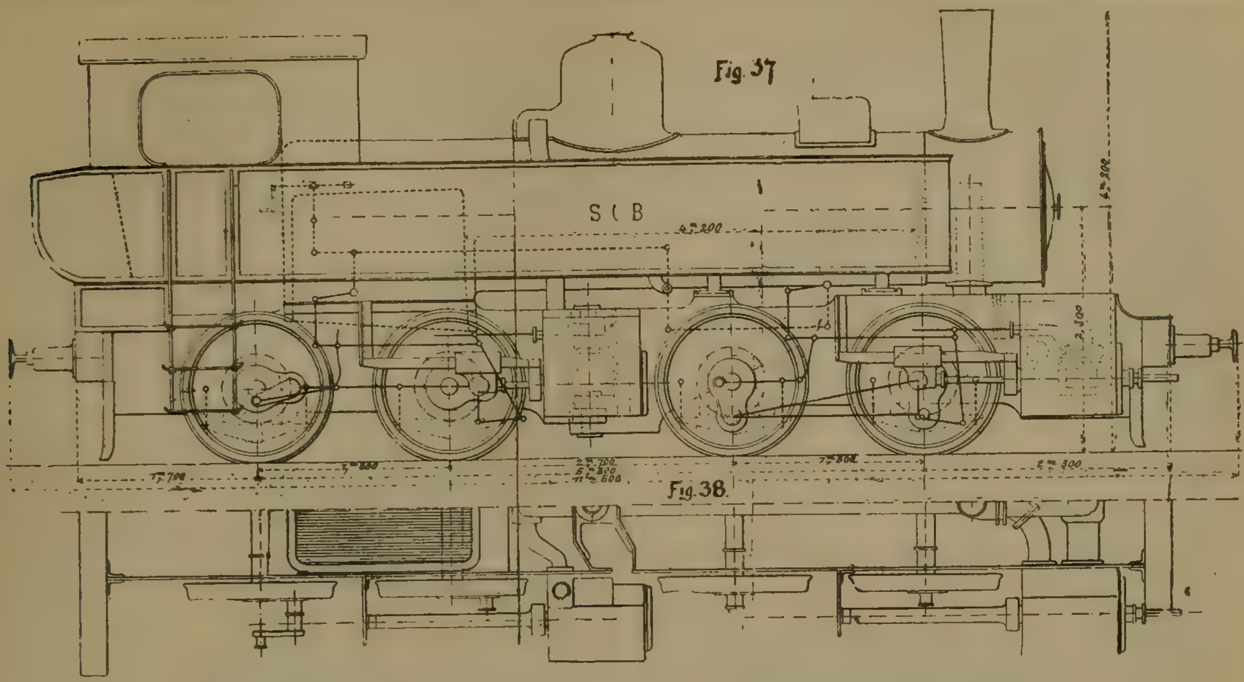

number of chains in *A B* will give the allowance in inches and decimals to be added to the distance for full chains of horizontal measurement.

Example: Let $A\ B = 3$ chains and the difference in height = 15 ft. $15 \div 3 = 5$ ft. By the table, the correction for 5 ft. is 2.276 in. Now $2.276 \times 3 = 6.828 = 6\frac{5}{8}$ in. to be added to *A B*, making 3 chains of horizontal measurement $A\ B = A\ F = G\ H$.

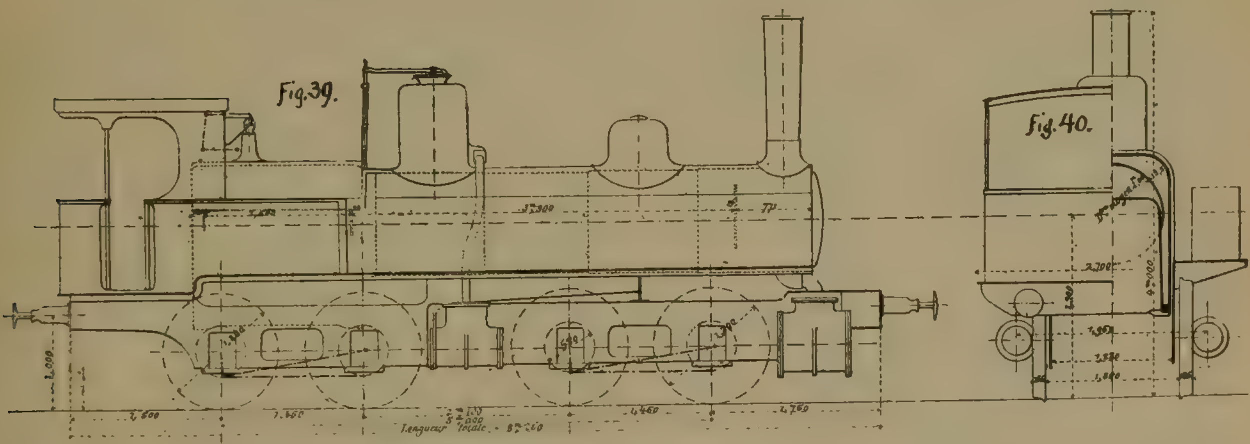
If the slope for 1 chain distance be such that *F* will not be out of reach, the forward end of the chain may be held up till the plumb line *F H* ceases to move forward, when it will be at the extreme outside of the arc at *F*, and the chain will be horizontal. The correction for 1 chain in ordinary measurement may easily be determined *mentally* with reasonable accuracy by multiplying the square of the difference of level in feet, as estimated by the eye by $\frac{9}{100}$ for the correction in inches and decimals. Thus: For 6 ft. difference, $6 \times 6 \times .09 = 3.24$ inches. Error $= \frac{1}{25}$ inch. For less than 6 ft. the error is still less.

| Difference in Height. | Correction. | Difference in Height. | Correction. | Difference in Height. | Correction. | Difference in Height. | Correction. |
|---|---|---|---|---|---|---|---|
| Ft. In. | Inches. | Ft. In. | Inches. | Ft. In. | Inches. | Ft. In. | Inches. |
| 1′ 0″ | 0.090 | 6′ 0″ | 3.280 | 10′ 9″ | 10.576 | 15′ 6″ | 22.151 |
| 1′ 6″ | 0.205 | 6′ 3″ | 3.559 | 11′ 0″ | 11.077 | 15′ 9″ | 22.881 |
| 1′ 9″ | 0.278 | 6′ 6″ | 3.850 | 11′ 3″ | 11.590 | 16′ 0″ | 23.625 |
| 2′ 0″ | 0.361 | 6′ 9″ | 4.153 | 11′ 6″ | 12.115 | 16′ 3″ | 24.381 |
| 2′ 3″ | 0.460 | 7′ 0″ | 4.467 | 11′ 9″ | 12.652 | 16′ 6″ | 25.149 |
| 2′ 6″ | 0.568 | 7′ 3″ | 4.793 | 12′ 0″ | 13.201 | 16′ 9″ | 25.930 |
| 2′ 9″ | 0.688 | 7′ 6″ | 5.130 | 12′ 3″ | 13.762 | 17′ 0″ | 26.724 |
| 3′ 0″ | 0.812 | 7′ 9″ | 5.479 | 12′ 6″ | 14.334 | 17′ 3″ | 27.530 |
| 3′ 3″ | 0.961 | 8′ 0″ | 5.840 | 12′ 9″ | 14.919 | 17′ 6″ | 28.348 |
| 3′ 6″ | 1.113 | 8′ 3″ | 6.212 | 13′ 0″ | 15.516 | 17′ 9″ | 29.180 |
| 3′ 9″ | 1.279 | 8′ 6″ | 6.596 | 13′ 3″ | 16.124 | 18′ 0″ | 30.024 |
| 4′ 0″ | 1.456 | 8′ 9″ | 6.991 | 13′ 6″ | 16.745 | 18′ 3″ | 30.880 |
| 4′ 3″ | 1.644 | 9′ 0″ | 7.398 | 13′ 9″ | 17.378 | 18′ 6″ | 31.750 |
| 4′ 6″ | 1.843 | 9′ 3″ | 7.817 | 14′ 0″ | 18.023 | 18′ 9″ | 32.633 |
| 4′ 9″ | 2.054 | 9′ 6″ | 8.247 | 14′ 3″ | 18.681 | 19′ 0″ | 33.528 |
| 5′ 0″ | 2.276 | 9′ 9″ | 8.690 | 14′ 6″ | 19.350 | 19′ 3″ | 34.436 |
| 5′ 3″ | 2.510 | 10′ 0′ | 9.144 | 14′ 9″ | 20.032 | 19′ 6″ | 35.357 |
| 5′ 6″ | 2.755 | 10′ 3″ | 9.609 | 15′ 0″ | 20.726 | 19′ 9′ | 36.292 |
| 5′ 9″ | 3.101 | 10′ 6″ | 10.087 | 15′ 3″ | 21.432 | 20′ 0″ | 37.239 |

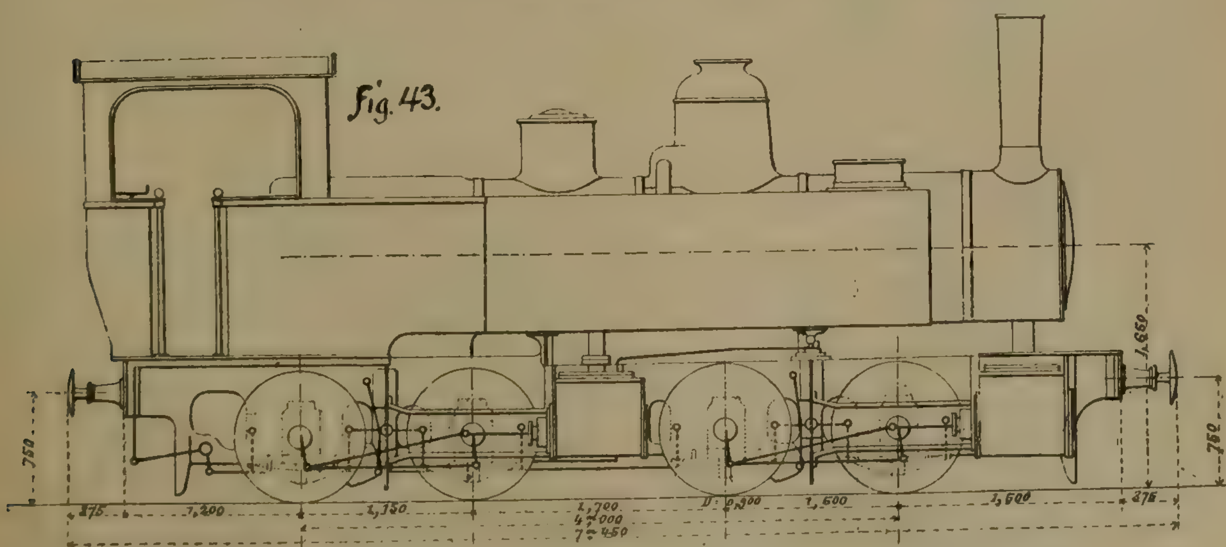
In the table the corrections are given in inches and decimals of an inch for differences from 1 ft. to 20 ft.




FOUR-CYLINDER COMPOUND LOCOMOTIVE, CENTRAL SWISS RAILROAD.




FOUR-CYLINDER COMPOUND LOCOMOTIVE, HERAULT RAILROAD.




FOUR-CYLINDER COMPOUND LOCOMOTIVE, DEPARTMENTAL RAILROADS.

## THE ELECTRIC LIGHT ON RAILROADS.

(Abstract of paper read before the National Electric Light Association, by W. H. Markland.)

AMONG the first to make use of the advantages afforded by electric lighting were the steam railroads; not as a means for lighting trains, but for lighting buildings, etc. In the year 1881 the Pennsylvania Railroad introduced its first electric lighting plant in a new shop in Altoona. That proved quite a success. It might also be mentioned that the same dynamo and lamps are in use to-day. In the year 1885 the Pennyslvania Railroad commenced lighting its depot shed in Altoona by arc electric light from its own dynamos, which proved a success as compared with the previous gas light, although it was crude to what the company now has.

The question then presented itself: Can freight yards be successfully lighted by electricity to reduce accidents, facilitate business and prevent breakage of cars and contents? The two latter items are quite a money consideration on any railroad.

In Altoona, when drawing up the plan for lighting the yards, the question presented itself: How high and how near together shall the lights be placed? the problem of lighting the freight yard being more complicated than lighting a city; as in lighting a city lamps can generally be placed at street corners and quite low, the general public being not over particular; so that under or near the lamp the light is quite brilliant, but in the space between lamps there is less brilliancy.

For lighting where engineers and trainmen have to work, it is not the brilliant light that is wanted, but the evenly distributed light. If a light be too brilliant, trainmen when near lamps will be partially blinded, as we might call it, for a short time; so in the event of their leaving a lighted space it would be difficult for them to distinguish objects or signals, and would lead to complaints.

In order to get an evenly distributed light, lamps in Altoona were placed on top of 65-ft. poles, these being about 8 ft. in the ground, and set so as to illuminate switches and crossovers where the yards were narrow. Where yards were wide and long, lamps were placed about 600 ft. apart, a row on one side of the yard and a row in a broad alley that was wisely left between tracks near the opposite side of the yard, the lights of the two rows being zig-zagged to prevent shadows and to better diffuse the light. This plan of lighting does not make a brilliant light at any point, it being possible, but difficult to read fine print. A light more like moonlight was the result, and proved very good in practice. Even a clear globe was objectionable on account of the shadows of side arms. A lower-half ground globe was preferable, it having been proved by experience that it was better to lose a little light than to have shadows.

One noticeable result followed the introduction of this light. It enabled the car inspectors to examine cars much more thoroughly, and, as you all know, perfect car inspection is very important. A decreased amount of pilferage also followed, as the watchmen were able to see persons at a great distance at night.

A few words about the erection of arc lamps and poles for freight yards. Poles must be very well set in the ground, and guyed so as not to sway from heavy rolling stock passing, or from wind. The poles, being high, receive the full benefit of the wind. A good, true chestnut pole for lamps, if possible to obtain, answers very well. They will cost when shaved, stepped and erected with hood about $35. The price will be governed largely by the cost of timber. Short poles must also be well put up, so that there may be no breaks.

Railroad people are very exacting; it does not do to have any stops or shut-downs. The lamps must be kept in good order. Maintaining arc lamps near railroads is quite different from maintaining lamps in most stores. If there is a poorly insulated part in the lamp, the soot will soon find a path for the current across the poor insulation, and out goes your lamp. Your cut-out contacts will corrode very fast. When it comes to your rods, expect to have a lot of dirty ones. In a railroad yard there are things to contend with not common with most lighting, and those are smoke and steam.

Get a good reliable, direct-current double carbon arc lamp that is well insulated. A lamp that is heavy, bulky or having liquids is not well adapted for the purpose, on account of the difficulty of carrying it up the pole. Do not rely on the hooks of lamps for connection between the lamp and the hanger board, or they will corrode and cause trouble. It is better to always put a piece of flexible wire from the hanger board to the lamp to carry the current. Always use a good insulated wire and good insulators when running up poles or side arms. It is better to splice on a piece of the very best insulated wire. Experience has proved that the wooden part of hanger boards is better for having some waterproof insulation between it and the side irons to prevent leaks.

I do not favor double-pole switches on hanger boards in freight yards, as they require extra contacts, the brass work of which soon corrodes so as not to make good connections, and leads to trouble.

The dynamo should be self-regulating and easily kept in order. As there may be 100 lamps, taking, say, two dynamos for all lighting at one point, it is better to put a little more money into dynamos than to pay high wages to the dynamo tender.

Keep as far away from telegraph and telephone lines as possible. If any damage is done to either of the above, the railroad generally gets the worst of the suit. If you are going to hire the lights from a central station, see that they give you good work, and make a contract with a rebate and fine for the time lights are out.

If you once properly put electric lights in a freight yard, you will never get them out again; the trainmen will not stand it, as they would be in the dark in more senses than one if the lights were taken away. But if the lights are not properly put in, say, on low poles, under 40 ft. above ground, or not properly spaced, the chances are there will be complaints on account of too much light at some one point and too much darkness at some other point. Great care should be taken to place lamps so they will not interfere with signals.

As to the other uses for electric lights for railroads, I do not know that there is much out of the regular run. The light is used quite extensively for lighting depot sheds, where it is more economical than gas and decidedly better. This class of installation requires the very best of work and insulation, as the smoke and steam nuisance enters in here. Even though depot sheds are dry inside, porcelain knobs should not be used, glass with a double petticoat being the only kind now on the market that answers the requirements well, on account of the soot settling on the insulators.

It does not do to have a depot in darkness; for that reason a depot shed should be wired with two complete circuits, having every alternate lamp connected to one circuit and the remainder to the other. Then, in the event of a break in the wire, only one-half the lights are out.

Experience has proved that the arc light is much superior to the incandescent for depot shed lighting. With incandescent lights the necessary volume of light is costly to maintain, and also the globes of incandescent lamps soon become dirty from steam and smoke, which interferes with the light, or takes considerable labor to clean them off.

For freight transfer stations the arc light is very satisfactory. It enables the men to quickly distinguish marks on merchandise, and also enables the foremen to see what the men are doing, preventing loafing. One 2,000 nominal candle-power arc lamp to about 1,500 sq. ft. of floor space will generally light a transfer station where lamps can be zig-zagged. Where transfer stations are narrow more light per square foot should be allowed. On a platform about 10 ft. wide, as they generally are, one light every 60 ft. gives good illumination.

I doubt if the arc light can compete with gas for this purpose as far as cost is concerned, taking transfer stations as they are generally lighted by gas and as they should be lighted by arc lights. Yet I believe, taking the amount saved in labor and from pilferage, that the electric lights more than pay for themselves.

I hear that an electric headlight has lately been brought out which it is claimed will illuminate a track for a mile or more. I am of the opinion that the light will not come into general use. In the first place, a light for this purpose should not be too strong, or it will blind an engineer coming in the opposite direction, this being a serious objection.

If any inventor wishes to get up an electric locomotive headlight, let him confine himself to one of low candle-power—the present ones are about 20-candle-power. I do not think one of over 100 candle-power will be in demand until railroads are illuminated from one end to the other by electric light, which will be the case in the future, and then the headlight will not be required.

These points are necessary for an electric headlight: First, and all important, reliability; second, simplicity. Economy you can leave out. If you can get 50 per cent. of what can be attained in a station, it will do. One thing must be borne in mind—engineers are not electricians. Thus a dynamo and lamp must be as simple as the air-brake, and no more liable to get out of order.

The experiment has been tried of lighting cars by electricity. While it has proved a success in some cases, as far as convenience is concerned, financially it has not proved a success. Electric lighting of trains is a luxury to-day, and will continue to be until some more economical plan is invented. The advance that is being made with the use of gas as an illuminant for cars is leaving electricity behind. From the best information I can get, it costs 50 cents per hour to light a car by electricity from storage batteries, against 5 cents per hour from carburetted air.

The electric light is used to some extent by different railroads for lighting wrecks or any construction work that requires night work. For this purpose the Pennsylvania Railroad and the Cumberland Valley road have a car fitted up with boiler, dynamo, engine, water tanks and coal bunker, and all the tools necessary for a central station. With a car of this description, quick work in getting lamps in place is all important. In one case, after the Johnstown flood, I, with the help of four men and the engineer, put up six arc lamps, put up the poles for the lamps (which were designed for the purpose and carried on the car), ran the wire, coupled up the lamps, and had the lamps going in 35 minutes from the time we, with the car, lamps, poles and wire, arrived on the ground. The lights were distributed some distance, one being about one-third of a mile away. I doubt if construction work was ever done quicker.

To give an idea of what the Pennsylvania Railroad Company thinks of the electric light, I might say that its new Juniata shops at Altoona, having about 100,000 sq. ft. of floor space, are lighted entirely by the electric light; there is not a pipe for illuminating gas in any of the buildings. All the traveling cranes are run by electricity.

The Pennsylvania Railroad Company believes that good electric work pays. I doubt if any station, central or isolated, has more reliable or better designed appliances or more artistic work than can be found at the Juniata shops of that company.

## THE SEINE TUNNEL.

THE construction of the new line of the Western Railroad from Port Audemer to Havre, which was intended to give a second railroad connection to that important city, required a crossing of the Seine near Quillebœuf, which was the most troublesome part of the proposed line. It was impossible to build a bridge over the river at that point without seriously obstructing navigation, and as on one side of the river the alluvial formation extended to a great depth, the building of an ordinary masonry tunnel would be very expensive. Under these circumstances it was at first proposed to use a steam ferry upon which cars could be carried across the river; but upon further investigation it was found that this would be much more difficult and expensive than was at first supposed, owing to the constantly shifting nature of the river banks, the great variations in the level of the river and the difficulty of making the crossing with a large ferryboat at certain stages of wind and tide, which would be sure to carry the boat out of its course. After some consideration a plan has been prepared for building a tunnel under the river. The total length of this tunnel between the approach cuttings at either end will be 4,500 m. (14,760 ft.); about 2,000 m. (6,560 ft.) of this distance on the eastern bank of the river is through solid ground, composed chiefly of chalk of different composition, and in this part an ordinary

Fig. 1.

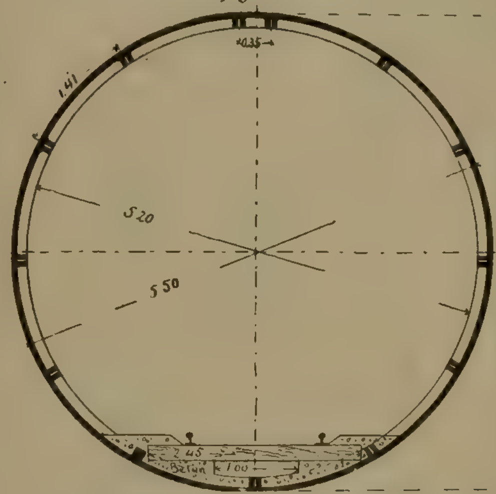



Fig 2.


masonry tunnel can be built without difficulty and without unusual expense. For the remaining 2,500 m. (8,200 ft.), which passes under the bed of the river and through the great alluvial deposit west of it, a tunnel will be constructed with cast-iron lining somewhat on the same principle which has been adopted for the Hudson River tunnel and for the recently constructed City and South London Railroad. The tunnel, which will only be large enough for a single track, will be circular in form, with an external diameter of 5.50 m. (18.04 ft.), a clear internal space

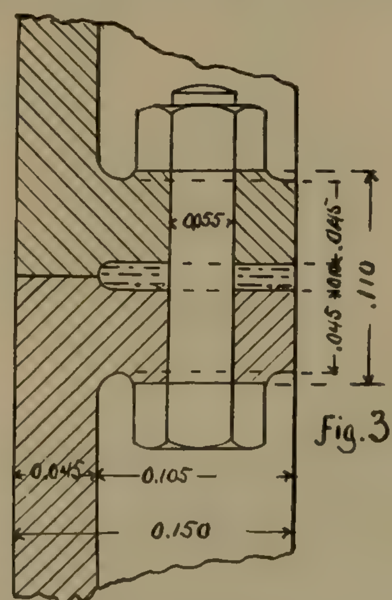



Fig. 3.

of 5.20 m. (17.06 ft.). The ties will be laid at the bottom in a bed of béton, in which, under the center of the track, a drain is provided to carry off water which may accumulate. In the accompanying illustration fig. 1 shows a section of the cast-iron tunnel, the dimensions being in meters; fig. 2 is a longitudinal section showing two lengths of the cast-iron rings of which the tunnel lining is composed; fig. 3 shows a joint in the cast-iron ring on a larger scale; fig. 4 shows one of the ventilating shafts, and fig. 5 a section at one of the recesses made for the workmen.

The tunnel will have from either end a descending grade of about 45 ft. to the mile, while in the center under the bed of the river the grade will be level for a distance of 560 m. (1,836.8 ft.). At each end of this level section a shaft will be sunk for drainage and ventilation, and the arrangement of one of these shafts is shown in fig. 4. The shaft will be lined with cast-iron segments similar to those in use in the tunnel, and will be 3 m. (9.84 ft.) in diameter, descending below the level of the tunnel, the lower portion forming a well into which the drainage of the tunnel can be discharged, and whence the water can

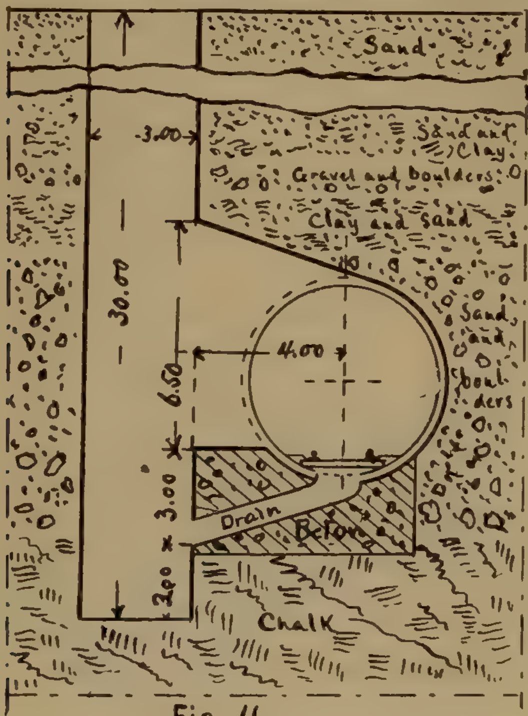


Fig. 4.

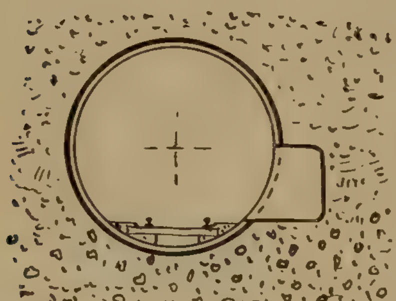


Fig. 5.

be pumped to the surface. At the level of the tunnel a large opening is made which will serve for ventilation. As the intention is to use only a single track, it is thought that the passage of trains from either direction will serve to clear the tunnel of smoke and gas, and it is also proposed to try a car of peculiar construction, having a circular front nearly filling the entire diameter, for this purpose also. If necessary, however, a system of artificial ventilation can be adopted.

As shown in figs. 1, 2 and 3, the tunnel lining will be composed of cast-iron rings 0.50 m. (1.64 ft.) in length, each ring being composed in its turn of 12 cast-iron plates, all of the same dimensions, and one smaller, or key-plate, placed at the top of the ring. The segments and the rings themselves will be joined together by bolts, as shown in fig. 3, with proper packing for the joints. At regular distances niches will be placed in which the men employed in the tunnel can stand during the passage of trains; one of these is shown in fig. 5.

The method employed in driving the tunnel will be substantially the same as what is known in England as the Greathead process, a shield being worked ahead of the tunnel under the protection of which the sand is excavated and the iron rings placed in position. The head or shield can be forced forward by hydraulic pressure, and the excavation can proceed steadily as it advances. With an iron lining it is necessary to take out very little more material than the space actually filled by the tunnel. In all cases it is proposed to protect the outside of the iron casting by a coat of hydraulic cement, which will be forced in as each ring is placed in position. This cement will, it is believed, protect the iron from rusting.

The cost of this metallic tunnel is very much less than of a masonry tunnel, and at the same time it can be carried out in places where the nature of the soil would render the excavation required for a masonry tunnel enormously expensive, or even impossible.

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## OUR NAVY IN TIME OF PEACE.

By Lieutenant Henry H. Barroll, U. S. N.

(*Concluded from page* 174.)

### THE NAVAL OBSERVATORY.

The Naval Observatory has for the greater part of its field of work scientific research into the realms of astronomy—a duty that the civilized world in all ages owes to future generations.

There is, however, much astronomical work done here that directly advances the interests of those engaged in commercial pursuits. The times of transit of various heavenly bodies are here computed, star tables arranged and published, signals sent each day to all parts of the United States, and time-balls dropped at exact meridian time, by electricity, that our clocks and chronometers may always be exactly regulated to the time of our several meridians.

It would be impracticable in the limits of this article to attempt to describe the various problems that enter into the study of the heavenly bodies and their motions. Some of these are intricate and almost hopeless problems; yet the final solution of these would bring us nearer to a knowledge of those laws that govern the universe; and there are none of us who do not realize that such work is of benefit to mankind.

Many of these investigations, such as the examination of the variable and recurring spots upon the sun, the flickering waves of the Aurora, and the effect of these phenomena upon the variation of the magnetic needle, are in the immediate advancement of civil interests.

The most important part of the astronomer's work consists, not in the taking of the observations, but in the collating, arranging and publishing in proper form of the results thus obtained.

In late years two new sciences have been called into use to assist astronomical research—Photography and Spectroscopic Analysis. Investigation of the heavenly bodies by the aid of these methods has been attended with good results. Their use in connection with astronomy has necessitated the invention of several new words, among which is Astro-photography, the title of one of the new methods of investigation.

Astro-photography has been largely used in recent observations of eclipses, and of the transit of Venus. Of all astronomical phenomena, the transit of the planet Venus probably contains for the astronomer the greatest amount of interest. It is from this transit that we are enabled to estimate, even as approximately as we now do, the distance from the earth to the sun, and to the various other planets of our solar system.

There are but two of the planets whose orbits lie between the earth and the sun. Mercury, nearest to the sun, travels in a path much closer to that body than to the earth. Observations of its transit, therefore, cannot be relied upon for the determination of distance, as a small angle would have to be used in order to determine a larger one—always a source of probable error.

In the case of Venus, however, its orbit being nearer to the earth than to the sun, the reverse of these conditions

obtains, while the planet itself being larger, the observation of its passage across the sun's disk is more practicable.

A transit of Venus, then, furnishes a means of procuring from the angular positions of the planet at the first, middle and last points of transit data from which, by a ratio of angles, we can approximately determine the distance of our earth from the sun ; and later, by the employment of this distance so determined, can also find that of the other planets.

Successive transits of Venus occur at intervals of about eight years ; and these times of transit are now looked forward to with great interest, since each recurrence of the phenomenon may give a little further insight into that unfathomable space that we call the universe.

It is of importance that the observations of the transit be taken from points widely separated on the earth's surface, that the lines of sight obtained may be as diverse as possible. Under the direction of the Naval Observatory, parties are generally sent to some foreign quarter of the globe for the purpose of observing this transit.

For many years the observation of the transit of Venus has been made, the earliest of which we have any record being that made in 1639 by Jeremiah Horrocks, a youthful English astronomer.

The observations made in 1761 and 1769 were attended with special success. The mean of the greatest and least distances of the sun from the earth, as determined by the observations of those years, was placed at about 96,000,000 miles. Later observations have tended to reduce this distance, which is now believed to be between 91,000,000 and 92,000,000 miles.

It may seem that there is not much accuracy reached when the distance sought after is still in doubt to the extent of a million of miles ; but it must be remembered that this is a result of a start from utter ignorance, and that the measurement has been made while the earth has been plunging along in her orbit at the rate of 19 miles a second.

### LONGITUDES BY ELECTRICITY.

Much danger to navigation results from the fact that many well-known points and headlands were in former times erroneously placed upon charts, owing to the wrong determinations of longitude. The determination of latitude is a simple problem, and is not so liable to error. The determination of the longitude of a place, however, depends entirely upon the accuracy of the time-piece employed in making the calculation ; and, therefore, many of the earlier established points were later found to be sadly in fault as regarded their geographical positions.

The manufacture of the chronometer, which gave to its inventor a handsome prize from the Royal Society of London, was the turning point in the establishment of correct geographical position. But it is in still later years that by the use of the electric cable, and its companion, the chronograph or time-marker, that we are enabled to discover the slightest differences in position of longitude.

The net-work of telegraphic cables which now encircles the earth facilitates the accurate determination of the longitude of some one point in each great geographical section, from which as an origin the entire systems of surveys of that country may be corrected.

As a matter of course this accurate determination by the use of the electric cable will greatly change the positions of some of those points located in ancient times by less exact methods. This error in the absolute position of capes, bays, shoals, etc., has no doubt been responsible for many of the disasters that have occurred in navigation ; and the Hydrographic Office has, for some years past, been sending parties to different parts of the world, making exact determinations of the latitudes and longitudes of points not accurately established.

It is the custom to determine closely the geographical position of some important point in a country, and then from the application of the error discovered in the former position of this point, as placed upon the chart, the entire coast-line of that country can be corrected.

In the determination of the longitude of the observatory at Cambridge, Mass., great care was exercised to arrive at its exact geographical position. It is stated that, in order to leave no room for error in this position, 50 chronometers were used in its determination ; and these were carried between Greenwich and Cambridge a number of times, the error of each instrument being cancelled by its return to the Greenwich Observatory, while the system gave not only a mean of the 50 chronometers, but a mean of a number of observations with each instrument.

Notwithstanding this attempt to obtain accuracy, and which was no doubt the most accurate way in which, in that day, the observation could have been made, the later use of the electric current, in making longitude observations between Washington and Greenwich, showed that Washington, as determined from the longitude of Cambridge as an origin, was in error to the extent of 18" of arc.

From Washington as an origin, this work has been continued southward throughout the West Indies and to South America—the true meridians of Havana, San Juan de Puerto Rico, St. Thomas, Port of Spain, Colon, Vera Cruz, Rio de Janeiro, etc., having been by the assistance of the ocean cables accurately established upon all charts.

### THE LIGHT-HOUSE SERVICE.

The looking out for the numerous light-houses and lighted beacons that have been established all along the coasts of the United States is a task of such magnitude that it is necessary to divide our territory into 16 separate light-house districts, each of which is under the charge of a naval officer as Inspector, who has charge of the supplying and the keeping in position of all of the aids to navigation in that district.

The First, to the Eighth Districts, inclusive, cover the Atlantic and Gulf coasts ; the Ninth, Tenth and Eleventh embrace the Northern Lakes ; the Twelfth and Thirteenth the coasts of California, Oregon and Washington, and the Fourteenth, Fifteenth and Sixteenth the Mississippi, the Ohio and their tributaries.

There are in existence in the whole world about 8,000 light-houses and lighted beacons. Of this number, over 900, or considerably more than one-tenth of the entire number, are owned and kept in order by the United States.

But the number of light-houses is small in comparison with the multitude of other aids to navigation, which are also of fully as much importance to navigators. There are thousands of buoys which no doubt seem to the landsman to have been placed at random in the various channels ; and yet it is of the utmost importance that each of these is kept as nearly as possible in its specified place.

Owing to the great difficulty in keeping some of these buoys in their proper places, small steam vessels are kept constantly patrolling the several districts and replacing those buoys that have dragged and repairing others that may have been injured. There are thus employed in the Light-house Establishment 30 steamers, known as light-house tenders, and these as a general rule are kept constantly at work. In our Northern ports it sometimes becomes necessary to remove the numerous buoys during the winter months, to prevent their destruction by masses of floating ice ; and in these cases the buoys are replaced as soon as spring weather assures their not being destroyed.

The importance of keeping these buoys in their rightful positions may be seen in the fact that all of the sea-board States have passed laws in regard to their being either accidentally or willfully removed from their proper positions. The penalty for even accidentally removing a buoy, or other authorized aid to navigation, and not immediately giving notice of the same to the proper authorities, is fixed, in the several States, at from $200 to $300 ; while there is a penalty of $50 for even anchoring on the line by which a range of lights would be obstructed.

The supplying of the various light-houses with provisions, oil, fuel, etc., for the running of the large lanterns, steam fog-horns and electric lights is a matter of the greatest importance ; and in the case of those light-houses marking outlying shoals or rocks is often attended with danger and difficulty.

As an example of the number of these aids to navigation, and the amount of work that their care must entail upon those having them in charge, may be cited the Fifth, or

"Baltimore" District, in which there are 110 light-houses and about 1,200 buoys, each of which can generally be depended upon as being in its proper position.

The Light-house Board annually publishes a newly corrected list of all lights on the coasts of the United States. There are also published for each district (in separate pamphlets) the list of the buoys in that district, together with an account of the position which each buoy occupies, etc., and these enable a navigator, when visiting this section for the first time, to avoid the many dangers that they are placed to indicate.

Thousands of these books are each year distributed, free of charge, to persons interested in maritime affairs. In each of these buoy books is printed a notice, requesting that any master of a vessel finding one of these aids to navigation out of place, or any light failing to properly illuminate its intended space, will give notice of the same to the Light-house Board. In answer to this, hundreds of items of information of this nature are being constantly sent to the Inspectors, and thus the channels and coasts are kept comparatively well marked.

INFORMATION FROM ABROAD.

Another important class of duty assigned to Naval Officers, and which is of direct advantage to manufacturers and shippers, is that of collecting information with regard to foreign ports. Especially is this of benefit in the case of those ports which are seldom visited, and which are but slightly known.

On every vessel in commission there is one officer who, in addition to his regular drill-duties and watch-keeping, is required to collect and forward to the United States such information as he can obtain with regard to the manners and customs of the people, their exports, imports, manufactures, custom and harbor dues, the depth of water, and facilities of access, etc., at all of the ports visited by this vessel.

The information that is thus being constantly forwarded to Washington finally comes before the citizen, but in many cases, possibly, through some channel that does not indicate the means by which it was collected.

It is not practicable in this article to attempt to describe the varied duties of those officers attached to the Navy Yards, in the equipment, navigation, construction, engineering and ordnance departments, or those assigned to duty in the manufacture and inspection of guns, projectiles and explosives, steel inspection, etc., yet all of this work is of the highest importance. It is not altogether to the man who fires the cannon that the credit of its splendid execution is due. We must not overlook the years of patient study, the result of which has been the evolution of the present Navy rifle, the 6-in. pattern of which recently demolished the English armor-plates designed to withstand the shot of a 10-in. gun.

In concluding this subject, however, it may not be amiss to take a general retrospection of what has been said with regard to naval duties. The introduction of the modern steel cruiser, to replace the obsolete wooden vessel, has necessitated numerous and varied changes; and our Navy is now in a state of transition from its condition in 1865 to an efficiency approaching that of foreign navies at the present time.

It has only been in the ships and their armament that the U. S. Navy has, at any time in this period, been behind foreign powers. It is unhesitatingly asserted that so far as the *personnel* of our navy is concerned, it has always favorably compared with those of foreign powers. Considering the material from which we have frequently been compelled to draw for crews for American men-of-war, the manner in which these men have been drilled and held to discipline has time and again called forth the highest praise from foreign naval officers, who recognize the difficulties with which American naval officers have had to contend.

The greatest care should be taken in the selection and education of those officers and seamen who are in the future to man our fighting ships. Until recently our vessels, although officered from the native-born population, have been almost entirely manned by seamen of foreign birth.

It is not fair to stigmatize these men simply because of the fact that they are foreigners. They have, as a general rule, fairly executed their contracts undertaken with the Government. They entered the service to obtain a certain amount of money and to do a certain amount of work; and in the majority of cases they have done what they contracted to do—either voluntarily, or else under the pressure that can always be brought upon them by judiciously applied punishment.

But while work and obedience can always be obtained by the fear of double irons or a term in Wethersfield, patriotism cannot in the same way be instilled into a man's heart; and, therefore, the best results will necessarily be obtained from enlisting only Americans to fight for the American flag.

It is but natural that the men picked up here and there all over the world, and who in many cases may have recently deserted or been discharged from vessels of other nationalities, will not man our ships as effectively as those who have the nation's welfare at heart, in addition to their own pecuniary interests.

In many cases such men would find aboard of an American man-of-war a comfortable birth, safe from detection and secure against the severe treatment and harder work of the merchant service, owing to the mild discipline and laws in his favor that prevail aboard of a Government vessel.

Seamen are proverbial growlers—especially those of the old school, who have been taught to consider this trait as one of their prerogatives—yet it becomes irksome to those who fully understand the true state of affairs to hear a foreign beachcomber (after having gotten his stomach well filled and his nakedness well clothed in the United States Navy) inveigh against the severe discipline and the hard work that prevails in the Government service, as contrasted with that ease and comfort he formerly enjoyed in the merchant service.

The persons most desirable for crews of modern men-of-war are, first of all, Americans—men who wish to find a home in the service. The navy is the last place in the world in which to seek a life of ease and idleness; nor should it be made an asylum for criminals fleeing from justice But the man who enters the naval service with the object of making this his vocation in life, and who exerts himself to learn thoroughly the profession he has chosen, whether as officer or seaman, will find it a pleasant life. Strict obedience is demanded, and will be enforced; and whether he proposes to enter as cadet or as apprentice, if he cannot first make up his mind that he is going to be subordinate to his superiors, he had better remain outside.

It is not mere food for powder that is desired. The typical old salt—the American man-of-war's-man of romance—had many fine points of character. In the day of sailing vessels there was not his superior on the face of the earth; but he has now about disappeared, and we find in his place a man of many parts—a curious conglomeration of boatman, electrician, artilleryman. soldier, sailor and engineer, and whom it would be difficult to classify under any one of these lines of duty.

The method of carrying on warfare has become a perfect system of machinery; and there has, perforce, been a radical departure from former methods. For example, the boarding of a modern vessel of war, when properly manned and officered, is, in this day of machine guns, as utterly impossible as would be the capture of one of our fast modern cruisers by the swift sailing frigate of 1812.

On the other hand, while machine guns and a "good look-out" give immunity from being boarded, the various types of stationary and movable torpedoes present another source of destruction of which our predecessors could not avail themselves, and against which they did not have to guard.

Torpedoes are, in their turn, rendered partly ineffective by constructing vessels with double bottoms and with numerous water-tight compartments; by the use of crinoline on the vessel's sides; by wire nettings and torpedo booms, etc.; while revolving search-lights serve to place the dangerous torpedo-boat at once under the fire of rapid-firing and machine guns.

The effect of the many recent changes in the methods of naval warfare cannot be accurately measured until two great maritime nations are brought into actual combat. Until then it is all a matter of conjecture. It is not practicable to produce a war in order to try the effect of smokeless powder, submarine boats and dirigible balloons. It is fair, however, to suppose that the next great conflict between maritime nations will, from the employment of these and other unproved agencies, add wondrously to the naval history of our times.

The most probable effect will be to require greater precaution, slower advance into action, less dash and greater precision of movement when once engaged. In this day, more than ever, will the man with the coolest head win the victory.

The ships, guns, motive power, even the men themselves, are mere parts of a gigantic machine, which can properly wield its immense force only when all parts are in thorough order and working in complete accord. It is needless, therefore, to say that Victory is most likely to perch upon the banners of that nation who has provided her navy with the best tools.

It is the knowledge of this absolute necessity for the proper class of vessels that leads so many naval men to raise their voices in favor of battle-ships.

It is generally supposed by those only partly acquainted with the subject, that when a naval officer advocates an increase in our force of naval vessels, he has some ulterior expectation of promotion on account of this increase. This is a mistake. He is actuated by the thought that it is a duty that he, as a professional naval man, owes to the country that has educated him ; and, of course, also, by his desire to be the better protected against the ignominy of defeat.

It is a mistake to suppose that an increase of promotion will necessarily follow from an increase in the number of ships. The number of officers allowed in each grade is fixed by statute, and remains the same, until altered by a law of Congress, no matter whether our navy be composed of wooden gun-boats or steel-clad battleships ; and an increase of the number of vessels allowed to the navy simply means a greater amount of duty for the same rank and pay.

When looked at in this light, it must excite respect to see how persistently the naval officer places to the front that which, although contrary to his mere personal comfort, he knows to be for the best interests of the country.

In forming an opinion of the amount of work that any class of people are accustomed to perform, we must be careful not to make our estimate from observations taken while these people are enjoying a holiday. It would be as reasonable to judge of the industry of the agricultural class from an inspection of a party of farmers at a county fair, as it would to form our opinion of the duties of a sailor, and use as a criterion the time he is ashore for recreation. There is not a busier class of people in our country than the officers and seamen who man our naval vessels.

It has been impracticable in this series of articles to do more than briefly outline the multifarious duties assigned to every one in the naval service, afloat and ashore ; but it is hoped that these have been sufficiently described to disprove the oft-repeated assertion that our officers and seamen form a part of the "Leisure Class" of the United States.

## A NEW FRENCH STEAMER.

THE accompanying illustration, for which we are indebted to the *American Shipbuilder*, shows the steamer *Polynesien*, recently completed at La Ciotat, near Marseilles, France, for the Compagnie des Messageries Maritimes and intended for the line between Marseilles and Australian ports. The *Polynesien* is the third of three similar vessels built for this line, the other two being already in service.

The principal dimensions of this ship are : Length, 502 ft.; beam, 59 ft. 6 in.; depth, 44 ft.; mean draft, 24 ft.; displacement, 8,638 tons. They are fitted with excellent accommodations for passengers and have plenty of room for cargo.

STEAMER "POLYNESIEN," COMPAGNIE DES MESSAGERIES MARITIMES.

The engines are of the triple-expansion type, with cylinders 44 in., 67 in., and 106 in. in diameter, by 54 in. stroke. With a piston pressure of 180 lbs. and 82 revolutions per minute, these engines developed 7,650 H.P. The speed in regular service is 18 knots an hour, which is unusually high for ships employed in Australian and East Indian service, as there are very few lines—outside of those between Liverpool and New York—where a speed of 15 knots an hour is exceeded.

The peculiarity of these ships is in the fact that steam on them is made entirely in Belleville boilers. This type of tubulous boiler was illustrated in the JOURNAL for July, 1890, page 321. In these ships the boilers are set in two lines placed back to back, as shown in the transverse section of the ship given in fig. 2. The *Polynesien* has 20 in all, placed in two groups of 10 each, one smoke-stack serving for each group. They are built to carry a working pressure of 200 lbs., but it could easily be increased if desired, so that the quadruple expansion, with 240 lbs. initial piston pressure, could very easily be used if desired. In the *Australien* and the *Tasmanien*, the sister ships of the one illustrated, several voyages have been made, and the working of the boilers has been admirable. Some time ago also the *Ortegal*, a freight steamer owned by the same Company and used on their La Plata line, was fitted with

Belleville boilers, and it was found that with an additional steaming power of about 40 per cent. the weight was not increased over that of the Scotch boilers.

In the *Polynesien* the total grate surface of the 20 boilers is 633 sq. ft., and the total heating surface 23,000 sq. ft. The entire floor space occupied, including a cross passage at each end of the boiler room and one between the two groups of boilers and the firing space at the outside, is 84 ft. 9 in. fore-and-aft by 29 ft. 6 in. athwartship, so that the boilers, fire-rooms and passages use about

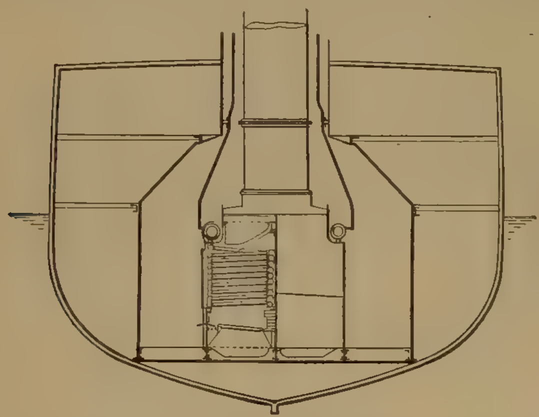


Fig. 2.

2,500 sq. ft. of floor room. In addition to the economy in space there are the further advantages of compactness and better distribution of weights, with opportunities for better ventilation and more convenient coal stowage, as the small room occupied by the steam generators permits the placing of the coal-bunkers immediately alongside of the fireroom. In addition to this we might mention the possible advantage referred to above, of a higher initial pressure and quadruple expansion, the economy of which will probably not be disputed by marine engineers.

## A COFFER-DAM WITHOUT TIMBER OR IRON.

(Condensed from paper read by Robert L. Harris before the American Society of Civil Engineers.)

In 1869 two bridge piers were built in Croton Lake, N. Y., but owing to the failure of the railroad company it was not until 1879 that a single-track deck bridge of three 150-ft. spans was placed upon them. This bridge was supported by iron towers 41 ft. 7 in. in height, the four columns of each tower resting on 12-in. granite blocks 6 × 5½ ft. in size placed at the corners of the old masonry piers. These piers were 20 × 7 ft., 32 ft. high, and rested on timber cribs 47 × 35 ft. As shown by the drawings, these cribs were of 4-in. plank laid cob-fashion, gained 1 in. and bolted together; each was divided into nine compartments and filled in with stone. One crib was in 18 ft. and the other in 20 ft. of water, and both had rip-rap around them.

In the winter of 1888-89 the writer had charge of the reconstruction of the bridge to meet the requirements of increased traffic. After the contract was let, holes were drilled in the large stones of the masonry bases for tests and to admit grout filling for possible cavities. After the first few inches the drills penetrated with little or no obstruction, and the removal of the top stones showed that the interior of the bases was empty, or filled up with loose stone, dirt, rubbish, etc., enclosed by only a thin veneer of masonry. The only exception was at the corners, where solid masonry had been built up from the crib to carry the columns of the old bridge, under the orders of Mr. A. P. Boller, who built it.

The tops of the cribs were 5 ft. below the surface of the water, and so were just inaccessible, except by diving or use of caissons or coffer-dams. The materials of the inside of the old masonry beds were removed as well as possible by men in rubber clothing, hooks, grapplers, etc.; but the water was very cold and muddy, and did not permit accurate work. The bottom of the lake was irregular, with many bowlders, and before disturbing the piers they were reinforced by rip-rap on all sides, with a berme of 7 to 10 ft. at the top of the cribs and an outside slope of 1½ to 1.

Several expedients were considered and rejected for excluding the water from the old masonry; forcing sheet piling through the rip-rap, covering the entire surface of the rip-rap with tarpaulin, etc. A tight bottom was desired at any level below the top of the crib, and tight sides thence to the water surface. The idea was to use the materials that were in place, and make a caisson therewith without disturbance, by cementing a portion of the loose mass of irregular stone-filling in the crib and as high as necessary to make good connection with the shell.

The track upon the bridge was over 75 ft. above the crib, and grout could be mixed upon the track over the crib and delivered directly through a hopper, pipe and nozzle. This was done, but the plan was soon changed to pumping in the grout immediately at the base. Holes were pushed among the stones until a few feet below the top of the crib. A long nozzle of 1½-in. iron pipe connected to the discharge pipe of a No. 2 Douglas hand force-pump was inserted in one of these holes to its bottom, the water was rapidly pumped through for a few minutes, then the suction hose was suddenly transferred to a reservoir of grout composed of Alsen Portland cement and fine sharp sand, in equal parts, mixed immediately before use; two or three barrels only of the grout were slowly forced through and the nozzle was then withdrawn, but the hole maintained, and the same operation was proceeded with at other distant holes, seldom returning to any hole on the same day. Mr. Harris's belief was that in quiet water the cement would accrete on the surface of irregular stones at and below the level of injection, and that by consecutive slight accretions at proper intervals of time the voids between them would be filled.

After many days of this work a 6-in. Edwards centrifugal pump was able to lower the water in the pier and a few days later to pump it dry. The excavation to the crib was then carried on with so little water that at times a single man at the hand-pump kept it free, and finally it was possible to put in concrete, 1 part Alsen cement, 1 part coarse, sharp sand, and 4 parts broken rock in solidly rammed layers, up to the top of the old masonry shell.

Upon this filling new stone piers were built 22 ft. 10 in. × 15 ft. 4 in. at the bottom and 18 ft. × 6 ft. 9 in. at the coping, and a little more than 40 ft. high. The new superstructure on these piers consisted of three single-track deck-spans each 156 ft. 9 in. centers. The weight upon the bed-plates of the old iron towers had been over 17 tons per square foot. The weight of the new structure and its extreme load, applied within the area of the skeleton towers at top of the bases, was under 3 tons per square foot, delivered at the crib at less than 2¼ tons per square foot. During the construction of the new piers slow trains were running regularly over the old spans, which were supported by the tower columns resting on the four almost isolated corners of masonry.

In this work Mr. Harris had made a cemented caisson in the crib, at a short distance below the top of coffer-dam, under water, using the loose stones there in place. Close observation during the operations failed to show loss of cement into the lake through the outside of the rip-rap. This is accounted for by the care exercised in forcing slowly but a little grout at a time at any one hole, and in giving it time to accrete upon the near rocks before another charge was applied.

This work was emphatically not done of choice, but under the necessity of using the old foundations, and to secure the best results under the existing conditions.

In conclusion, Mr. Harris stated that this process of grouting can be successfully applied to rip-rap, rubble, gravel, sand and quicksand, and for the convenient construction of coffer-dams, breakwaters, etc., from the materials at hand or in place, and that it is useful for enlarging or repairing various subterranean or subaqueous tructures and foundations.

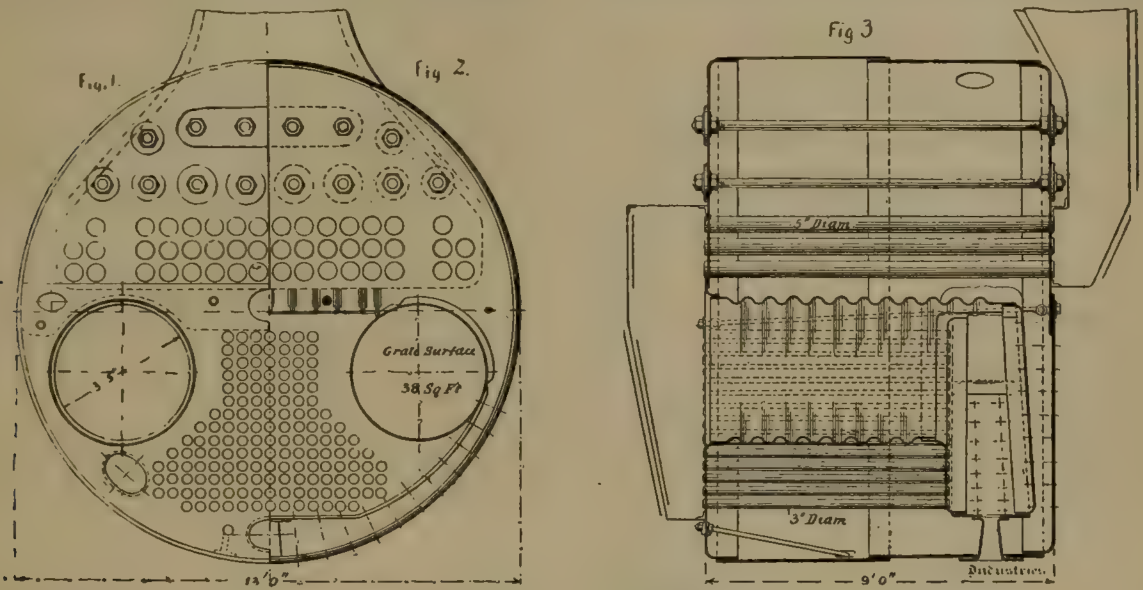
In the discussion following several instances were

given of piers founded on loose stone and of masonry strengthened by forcing in cement. Mr. Harris said that about 100 barrels of cement were used for one of the piers and 134 for the other, and that considerable difficulty was experienced by the force-pumps clogging with grout when it was made as at first, with sharp, coarse sand. The difficulty was, however, relieved by using sharp, fine sand. Mr. Harris described taking from the foundations, 6 feet from the nearest nozzle, a broken stone with sharp, acute edges, on the vertex of which was an accretion of cement one-half inch thick. He particularly emphasized the special point of the paper as being the idea of utilizing, in special cases, the existing loose materials for a tight permanent barrier, or for enlarged footing area, and that a very slow, gradual, intermittent application of liquid cement mortar in calm water would, by the sticking and setting of successive thin films form large accretions on the surfaces of the adjacent materials, which would thus become monolithic. The examples referred to in the discussion were of grouting in practically dry places, which is a familiar operation and well illustrated in the New Croton Aqueduct. Grouting under water has been done in England by W. R. Kinipple, who used experimental boxes filled with broken stone, to be joined by cements. In his harbor work, where the existing cavity was not limited, he constructed walls to confine the cement. Mr. Harris's method is a new application of cement under water, operating by gradual accretions, similar to natural processes, and not requiring any sides or bottom to confine it.

## THE CARSON MARINE BOILER.

THE accompanying illustrations show an improved form of marine boiler devised by R. Carson, of Hull, England. Fig. 1 is a half front view; fig. 2 a half cross-section; fig. 3 a longitudinal section of a boiler built for the steamer *European*, a vessel lately refitted with high-pressure boilers and quadruple expansion engines by the Earle Shipbuilding Company at Hull.

The principal feature of this boiler is the use of two distinct set of tubes, the lower ones being 3 in. in diameter, and the upper ones 5 in. in diameter. The gases first pass from the combustion chamber to the lower tubes, and then through the upper ones on their way to the funnel. It is therefore likely that by this arrangement the temperature of the escaping gases will be considerably lower than in the ordinary marine multitubular boiler, and thus economy of fuel will be effected. Careful experimental trials and actual practice in ordinary working confirm this conclusion. The boiler, which is 13 ft. in diameter and 9 ft. long, has two corrugated furnaces 3 ft. 5 in. in diameter, with a grate surface of 38 sq. ft. and a total heating surface of 1,500 sq. ft. This boiler burns 20.3 lbs. of coal per square foot of fire grate, and is said to evaporate 10.1 lbs. of water per lb. of coal, calculated at an absolute pressure of 195 lbs. These results, if correct, are very satisfactory. Apart from economy of fuel, this design of boiler has an advantage in equalizing the temperature of the boiler when steam is being raised. The circulation of the water is ensured by the gases at their maximum heat passing through the lower set of tubes, and it will be seen that these tubes are so arranged that there is scarcely any water in the lower part of the boiler which does not have heat directly transmitted to it.—*Industries*.




THE CARSON BOILER.

## NOTES FROM CHINA.

THE Viceroy of Kwangtung and Kwangsi has determined to build a railroad from Kowloon, opposite Hong-Kong, to Canton, a distance of 125 miles.

This will make the third railroad within the Chinese Empire, the first being the Tientsin-Kaiping Railroad, and the second, the North Formosa Railroad.

The Tientsin-Kaiping line has recently been extended to Linsi, a distance of 11 miles.

The building of the Kirin extension is expected to go on during the present year, but as yet no definite announcement has been made.

### MINING.

The Viceroy of Hupei, Chang-Chih-Tung, has just issued a proclamation urging native companies to open the coal and iron mines of Hupei, and promising them government assistance and support in introducing foreign machinery, and obtaining the services of foreign engineers.

Six American miners and an Ingersoll air-drill plant have been recently added to the force and machinery of the Jeho silver-mines (Northern Chihli) by the manager, Tang-King-sing, who is also the successful manager of the Kaiping colliery. The Jeho mine has not fulfilled the expectations entertained in regard to it up to this time, but work is now to be pushed more energetically in the hope that it may soon be put on a paying basis.

John A. Church, formerly the Superintendent of the Jeho mine, has returned to the United States. Before his departure he visited Kurichow at the request of the Chinese authorities, and his visit led to important discoveries of coal-mines in that province.

## NATURAL ASPHALT AND THE PRESERVATION OF IRON AND STEEL STRUCTURES.

By A. B.

In the valuable paper of Mr. Woodruff Jones on "The Preservation of Iron and Steel Structural Work," in the April number of the Journal, an observation is made respecting "asphalt and coal-tar paints," which requires some further and definite statement of facts to prevent it from being misleading. He remarks that "asphalt and coal-tar paints run when exposed to the sun and other sources of heat, which is a serious matter with vertical surfaces, and after a time become extremely brittle and scale off entirely, leaving the under surface exposed unless the paint is constantly renewed. In the mean time, the exposed iron and steel are being corroded by rust." This is undoubtedly true with respect to such so-called "asphalt" paints as have hitherto been in the market for structural work, to which it is presumable that Mr. Jones intended his remarks to apply. But they do not at all apply to a paint of which almost the entire body is natural asphalt, as the name ought to imply. Such a paint does not run when exposed to the sun and other sources of heat; does not after a time become brittle and scale off and require constant renewal; and therefore does not leave the iron and steel exposed to corrosion by rust. A well-made paint, the body of which is of true natural asphalt, can be subjected to any amount of heat on vertical surfaces not above that of boiling water and not run; and its qualities of toughness and adhesiveness are remarkably persistent and durable. Its covering quality is also excellent, and for exclusion of moisture and prevention of rust it has no superior, if it has any equal. So adhesive is it and so completely does it prevent corrosion, that when a new coating is required it is best to apply it over the old paint, with little or no scraping, thus saving a considerable item in the cost of maintenance.

The trade use of the term "asphalt," as applied to certain coal-tar products, has naturally led to some confusion of mind on the subject. But, while these artificial products have a certain resemblance to natural asphalt in some of their physical properties, they are yet chemically very unlike. They are, in fact, so wide apart in essential qualities that they are as inappropriately coupled together in the same sentence as if closely related, as things volatile and involatile, or destructible and indestructible. There is no product of coal-tar, until the final residuum of coke in the still, the constituent oils of which do not gradually volatilize by the heat of the sun; and coal-tar products suitable for use in paints also easily become fluid when subjected to heat, so that they are liable to run on vertical surfaces, until, by evaporation, they are so far advanced on the road to brittleness that they solidify, and by a little further progress in the same direction they become brittle and scale off. On the other hand, a true asphalt paint applied on vertical surfaces does not become fluid when exposed to the sun or other source of heat; and its constituent oils are absolutely non-volatile at the highest temperature of the sun's heat, and do not change by oxidation under any ordinary atmospheric conditions—very essential qualities of permanence. It is these properties which make the finer kinds of asphalt so important in the manufacture of coach and other black or dark Japan varnishes. The wonderful permanency and durability of natural asphalt has been demonstrated by the experience of ages. For example, Herodotus tells of its use in the construction of the walls of Babylon, and this is confirmed by modern travelers, who find abundance of asphalt among the ruins of this ancient city. Sir R. Kerr Porter speaks of picking up among the ruins of Babylon "large cakes of asphalt, more than 10 in. long and 3 in. in thickness, appearing to have been the casing of some work, perhaps the lining of a water-course." These had lain exposed to the elements for more than two thousand years, and yet retained their forms so as to indicate their probable purpose. With any substance that becomes brittle and perishable under the heat of the sun this would, of course, be impossible.

## SOUTH AMERICAN NOTES.

### BRAZIL.

Our Brazilian correspondent, writing about the middle of March, says that he understands that announcement has been made that capable engineers would at present do well to try Brazil. Upon this head he makes the following remarks, which, we believe, will be useful to engineers in this country and elsewhere.

"So far as I am able to judge, such an announcement is decidedly misleading, and I think you will do well to discourage any engineer who has fairly good prospects at home from coming to a country in which politics and finance are both as unsettled as they are at present in Brazil, unless he has either a contract in his pocket provided for payment to his credit in an American bank of a good proportion of its salary in American money, or unless he has extraordinary influence with influential Brazilians. It must be borne in mind that under the new Government patronage, for a time at least, will take small account of individual merit; that the amount of work actually in hand in Brazil is very small; that the foreign companies executing works here generally import their engineers under contract from their own country; that Brazil has but little capital, and at present a very uncertain credit. Moreover, the recent smash in the Argentine Republic has turned loose a great many engineers, of whom many try Brazil before crossing the Equator.

"For a skillful promoter Rio Janeiro may be a profitable hunting-ground for some time, but for an engineer it is a very doubtful one."

### ARGENTINE REPUBLIC.

The Transandine Railroad was opened as far as Uspallata, and trains commenced to run through March 1. The terminus of this line is now close to the end of the mountain section, but when it will be completed is very uncertain, as work is for the present suspended on the crossing of the Andes, owing to financial disturbances.

Argentine managers are urging a general reduction of railroad fares and freight rates. In the present condition of the country they believe that this will be beneficial, both in reviving business and in improving the condition of railroads. The difficulty, however, is that most of the lines are owned in England, and that it is almost impossible to make the London directors appreciate the true state of affairs, or to understand that an increase in profitable business may often be brought about by reduction in rates in a new country.

The first iron made in the Argentine Republic was made from hematite ores taken from the Romay Mine, recently discovered in the province of Catamarca. The ore is said to be of excellent quality, and to exist in that province in considerable quantities. The iron made from it in a small furnace built for experimental purposes was of a very good quality. It is not at all likely, however, that a country in which fuel is as scarce as it is in the Argentine can ever become a great iron-making country. Fuel as well as iron ore is urgently needed.

## THE UNITED STATES NAVY.

The third trial of the *Bennington* began April 1, but was postponed for a day on account of the breaking of a pump-rod. The damage was repaired and the trial made finally on April 2, when the ship made the required five hours' run, extending from a point off Matinecock Light through Long Island Sound to near Bartlett's Reef Light. The data reported are: Average steam pressure during the run, 161.6 lbs.; vacuum, 24.4 in.; revolutions of main engine, 151 per minute. The engines worked smoothly and well, developing a little more than the 3,400 H.P. required.

It is stated that no contract will be awarded for the new torpedo boat, for which bids were received some time

ago; and it is not unlikely that the boat will be built at the New York or the Norfolk Navy Yard.

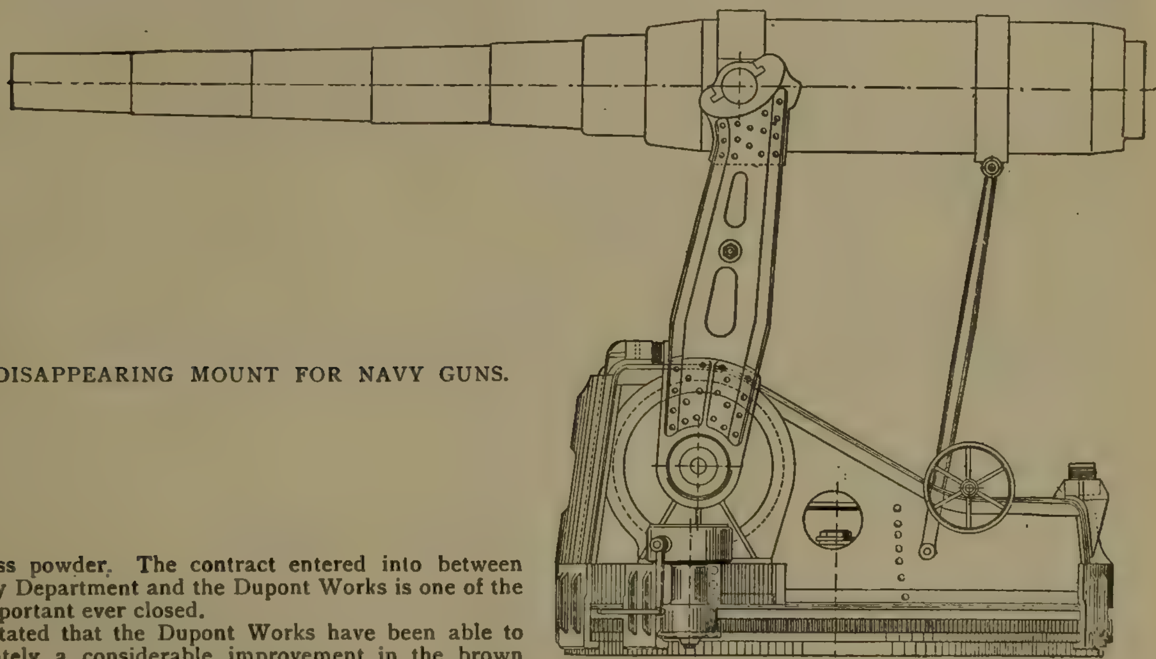
ORDNANCE NOTES.

The Secretary of the Navy has closed a contract with Dupont & Company, of Wilmington, Del., by which that firm will be enabled to establish a plant at their powder mills for making gun-cotton and smokeless powder for naval uses. The plant to be located at the Dupont Works is the first of its kind in this country. Experiments have been conducted during the last year by the naval ordnance experts with high explosives, and some valuable results have been attained, notably with emmensite, a material in force about equal to that of gun-cotton. The latest report from the Torpedo Station, where the chemical experiments have been conducted, show that the powders adopted abroad fail in complete homogeneity and perfect stability. Meanwhile the foreign tests are closely observed and samples are analyzed at home, with the result that the bureau is ready to domesticate in this country the manufacture of smokeless powder. The contract entered into between the Navy Department and the Dupont Works is one of the most important ever closed.

It is stated that the Dupont Works have been able to make lately a considerable improvement in the brown prismatic powder used for high-power guns. In a recent test at the Naval Ordnance Proving Ground, in an 8-in. breech-loading rifle of 35 calibers length, it gave to the projectile an initial velocity of 2,130 ft. per second, with a pressure in the powder chamber of only 14.8 tons per square inch. This is equivalent to an increase in the power of the gun, which is designed to give an initial velocity of 2,080 ft., with a chamber pressure of 15 tons. The improvements in the powder have been such as to give it greater uniformity of combustion, so that the speed of the projectile is more gradually accelerated throughout the length of the gun, until it leaves the muzzle with a higher velocity than could be attained with the older powder.

The Bureau of Ordnance has prepared drawings for a hydraulic disappearing mount for a 10-in. breech-loading rifle. It resembles the pneumatic carriage in general principle, except that water under a pressure of 800 lbs. to the square inch is used in place of compressed air. The gun rests upon two arms, the lower ends of which are keyed to the two ends of the axis of a horizontal cylinder. This cylinder is divided into two compartments by a fixed diaphragm. The water is admitted through valves into these compartments and the gun is elevated. By turning the axis of the cylinder the water is forced out through small grooves, resisting the recoil sufficiently to bring the gun to an easy stop at the loading position. A mount is to be constructed on these plans and thoroughly tested.

For the accompanying illustration of this disappearing gun-mount we are indebted to the *Army and Navy Register*, of Washington.



THE DISAPPEARING MOUNT FOR NAVY GUNS.

## THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.



(*Continued from page* 170.)

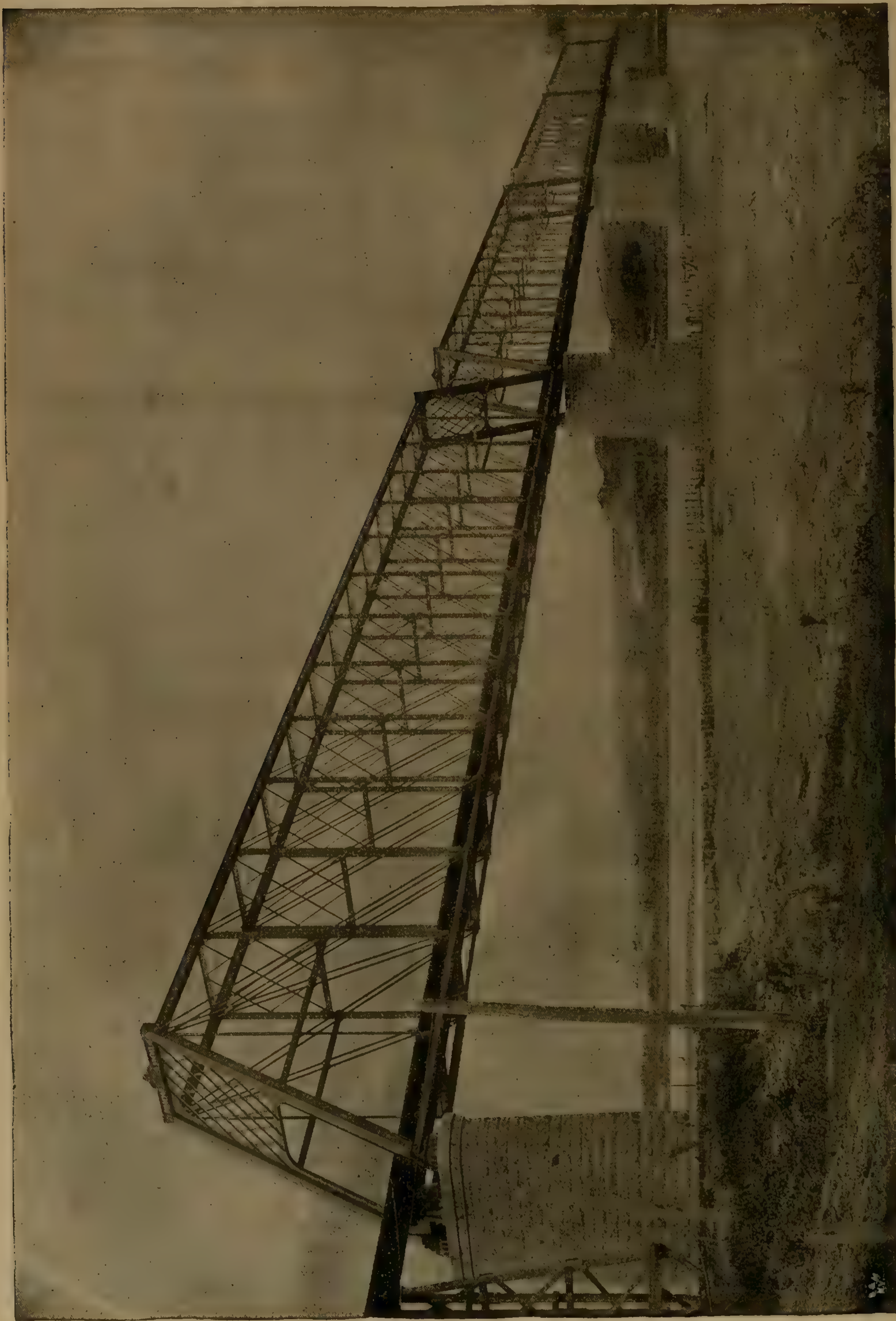
### XII.—TORPEDOES.

A sea-coast attack in the olden time—a fight between ships and forts—was, relatively speaking, a very simple affair. Given depth of water and manœuvring space, the factors were simply those of relative strength of wall and bulwark, weight of metal and good or bad gunnery. For the defense, the only auxiliary aid available came from booms, to delay the approach, and fire-ships, to damage an assailant. How greatly the conditions have changed, so far as concerns the defense, may be gathered from a statement of what is now considered necessary for the proper protection of a harbor. In addition to forts and batteries, the first need is a carefully planned system of controllable submarine mines; then controllable torpedoes ready to dart out from the shore at the will of their operator; floating batteries of light draft, armed and armored more heavily than any probable adversary, and lastly, swift torpedo-boats for the protection of the mine-field, for harassing a blockading fleet, to pounce upon an enemy's ship that may become disabled or get aground, and to take every advantage afforded by fog or smoke or darkness for attacking him.

What has heretofore been said concerning the defense of a harbor has had reference to the purely passive or stationary means employed for that purpose. Under the head of *torpedoes* reference is had to all the movable and aggressive contrivances for inflicting injury upon an enemy's shipping, whether acting upon or beneath the surface of the water. Like submarine mines, torpedoes are divided into two general classes—*uncontrollable* and *controllable*—the name clearly indicating the characteristic feature of each.

### XIII.—UNCONTROLLABLE TORPEDOES.

In the uncontrollable class are included every torpedo which passes, when once launched, wholly beyond the control of the operator, both as regards its direction and its propelling force. Various methods have been adopted,



THE SIOUX CITY BRIDGE OVER THE MISSOURI RIVER.

with more or less success, looking to the maintenance of a true direction when once the torpedo has started upon its course, but no means have been devised for securing its explosion except by contact with some other body, or by mechanism that shall act at the expiration of a definite period of time, regardless of its then position in relation to the object of attack. In this class are the *projectile*, the *rocket*, the *drifting*, and the *auto-mobile* torpedo.

*Projectile torpedoes.* All torpedoes projected against an enemy, whether the actuating impulse is extraneous to themselves or self-contained, can be classed under this head, but the term as usually applied is restricted to "a case of explosive projected through the water from a submarine gun." The best-known example of this class is that invented by Captain Ericsson, intended to be fired from a breech-loading gun or tube built into a vessel especially designed for the purpose (the *Destroyer*). The gun is submerged some 7 ft., closed by two water-tight valves, one of which, of wood, is supposed to be shot away and replaced after each discharge. A gunpowder charge of 25 lbs. gives a range of some 400 ft. to a torpedo carrying 300 lbs. of explosive. It was experimented with in 1881 with fairly satisfactory results. Recently it has been taken in hand again, and further trials will shortly be had. The claim made for this system of torpedo discharge is that the vessel can be so heavily armored as to be practically invulnerable—wholly unlike the ordinary torpedo-boat.

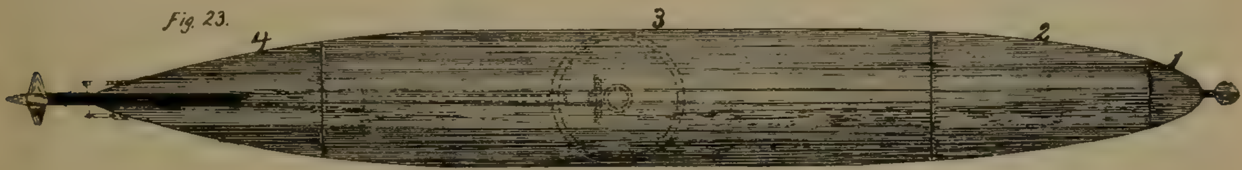
Neither the *rocket* torpedo, which class embraces all those that depend for their propulsion upon the gases developed by the burning of some form of rocket composi-

machinery. There is considerable variation in dimensions, weight and charge of explosive.

The *Howell* torpedo (fig. 23) has much the general appearance of the Whitehead. The shell is of brass, the other parts of steel or phosphor-bronze. The body is divided into four sections: (1) The nose, carrying the firing-pin and its mechanism; (2) the explosive charge and detonator; (3) the fly-wheel and screw gears, and (4) the diving and steering mechanism. The propelling power is stored in a steel fly-wheel, given a high velocity of rotation before the torpedo is launched. This power is transmitted directly from the fly-wheel to the propellers. The diving mechanism, which controls the submersion, is operated upon by hydrostatic pressure, and can be set for any depth from 1 to 12 yards. After launching it automatically takes the depth for which set, and maintains its course both vertically and longitudinally. The fly-wheel can be worked up to 10,000 revolutions per minute, which will give a speed of about 22 knots for 400 yards, and an extreme range of about 1,000 yards, although beyond the shorter distance there will be a considerable loss of speed. The 8-ft. torpedo will carry 70 and the 9 ft. 90 lbs. of explosive. For accuracy it is superior to the Whitehead, but the latter has the greater range and velocity.

*Torpedo discharge.* An initial impulse is necessary to throw the torpedo clear of the ship into the water. This impulse may be given either by steam, compressed air or gunpowder. Air and gunpowder are now usually employed, the latter becoming the prevailing method. The discharge may be either below or above the surface, either from fixed, or from training or turntable tubes. For

*Fig. 23.*




tion, nor the *drifting* torpedo, have at present any recognized place in the list of practicable weapons.

*Auto-mobile torpedoes.* The auto-mobile fish torpedo is the only one of the uncontrollable class that has reached a practical stage of development, and that has a recognized place in the torpedo armament of the great powers. In it the power of propulsion is self-contained, and it may be run either upon or at any desired depth below the surface of the water. The European Whitehead is the best-known example of this class, but this has now a more than promising rival in the American Howell. The German Schwartzkopf is simply a modified Whitehead. All the weapons of this class are alike in that they are cigar-shaped bodies, of a length varying from 9 to 19 ft., with a maximum diameter of from 14 to 18 in.

The *Whitehead* torpedo first appeared upon the trial ground in 1868, under the auspices of the Austrian Government. As at present constructed it is a cigar-shaped body of steel or phosphor-bronze divided into six compartments for the propelling, directing and exploding mechanism. It is driven by two screws, revolving in opposite directions upon one shaft, the motive power being air-compressed under a pressure of about 1,000 lbs. per square inch, and an engine. It has an extreme range of about 800 yards, and a speed up to the half of this distance of 30 knots per hour. The details of the latest models are given as follows: Length, 11.5 ft.; diameter, 17.5 in.; charge, 110 lbs. wet gun-cotton, and weight about 800 lbs. In the Whitehead advantage is taken of hydrostatic pressure to regulate the immersion. It is maintained at a constant depth by horizontal rudders, controlled by what are known as "immersion regulators;" and in a vertical plane by fixed vertical vanes. The chief defect of this torpedo seems to be a want of stability in a horizontal plane. It is at present the only one in actual service—using the name to indicate the type—and forms the armament of all European torpedo-boats. The Schwartzkopf is, in all essential particulars, a Whitehead, differing from it in the material for the air-chamber (phosphor-bronze), and in some slight degree in the steering apparatus and motive

under-water discharge the tubes are always fixed, and from 7 to 9 ft. below the surface; either in the stem for forward or on the sides for broadside discharge. Owing to the turmoil created by the propeller, stern discharge is apt to be uncertain. For above-water discharge the tubes are usually movable, and from 5 to 9 ft. above the water-line. To aid in accuracy of discharge, spoon tubes are often provided. These prolong the tubes about half the length of the torpedo beyond the sides of the vessel, and may be rigged out at pleasure.

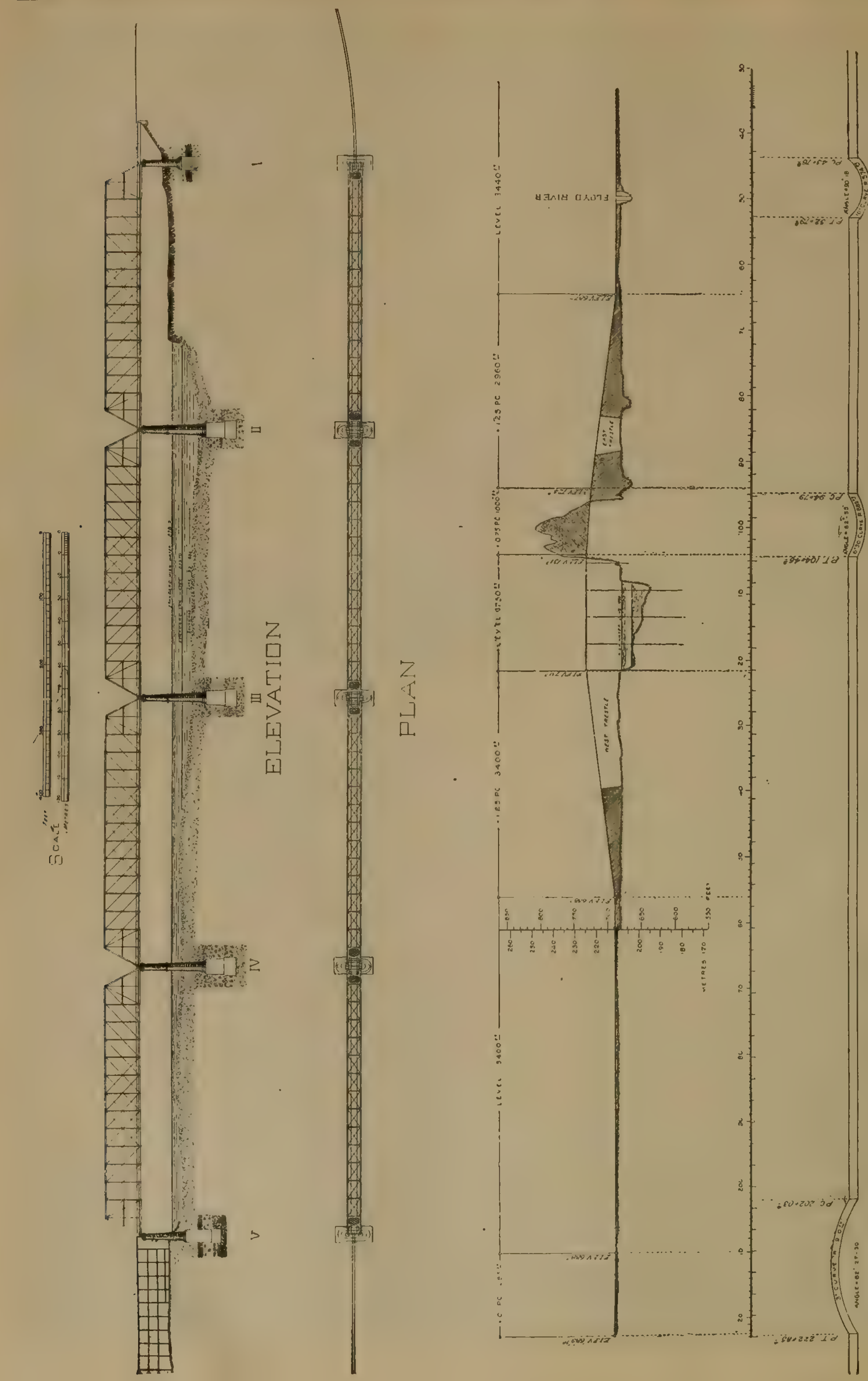
For gunpowder discharge the French use a disk of ¾ lb. of compressed gunpowder. With air impulse the pressure is something over one atmosphere. In either case the force employed is only sufficient to throw the torpedo clear of the side. It should fall flat upon the water, when its own motive and directive apparatus sets it upon its course at the proper depth, and supposedly in the right direction. Generally speaking, England and France employ gunpowder impulse only; Austria, Germany and Spain, air impulse, and Italy and Russia both. England, France and Italy use both above and under-water tubes; Austria and Russia above-water discharge only. Not only are torpedo-boats provided with tubes and torpedoes, but a large percentage of recently constructed war-ships have a torpedo in addition to their ordinary armament.

(TO BE CONTINUED.)

## THE SIOUX CITY BRIDGE.

MR. MORISON'S report on the Sioux City Bridge* is a very fully illustrated monograph, containing a full description of the bridge and approaches, from which, with the permission of the author, we have taken the accompanying engravings and a condensed description of the bridge itself. The bridge was built to connect the Chicago & Northwestern and the Chicago, St. Paul, Minneapolis & Omaha Railroads by a crossing of the Missouri River in

* THE SIOUX CITY BRIDGE: *A report to Marvin Hewitt, President of the Sioux City Bridge Company.* By George S. Morison, Chief Engineer.




THE SIOUX CITY BRIDGE OVER THE MISSOURI RIVER.

the neighborhood of Sioux City, and was constructed under the charge of Mr. Morison as Chief Engineer.

It is a single-track railroad bridge, and as originally designed consisted of three spans of 400 ft. each, resting on masonry piers, with a plate girder span extending from the east pier to the bluff, and with a short deck span connecting the west pier with the west approach. Owing to changes in the channel of the river, which in the winter of 1887–88 changed to the west side instead of the east side of the river, it was decided to increase the length of the bridge and to make it consist of four spans of 400 ft. each and a plate girder span 61 ft. 6 in. long east of pier I, the total length of the bridge proper being 1,675 ft.

The east approach includes a bridge across the Floyd River, consisting of three spans of plate girders resting on two masonry abutments and two iron cylinder piers, all having pile foundations. It also includes a timber trestle 600 ft. long. The remainder of the line is of earthwork, all being embankment except a large cut through the bluff immediately east of the bridge. The total amount of material in this approach was 166,929 cub. yds.

The west approach comprises a timber trestle 1,840 ft. long, extending west from pier V, beyond which it is all built as an earth embankment, the total amount of the earthwork in this approach being 66,382 cub. yds. Both approaches are built with a maximum grade of 1.25 per cent., or 66 ft. to the mile.

The illustrations herewith show an elevation of the bridge and approaches; a plan of the same and the general alignment of the bridge and approaches. The large plate is a general view of the bridge, taken from a photograph.

The superstructure of the bridge proper, as above noted, consists of four through spans and one plate girder, each through span being 400 ft. long between the centers of the end-pins, divided into 15 panels of 26 ft. 8 in. each, the trusses being 50 ft. deep and placed 22 ft. between centers. Expansion is provided on piers I, III and V.

Excepting the web plates of the plate girder, the entire superstructure is of steel. The east span is of imported steel from Scotland; the other three spans are of American steel. The imported steel, it is stated, was a little more uniform in quality than the American, but was less uniform in finish and sections, and the weight of this Scotch steel span is slightly in excess of that of the others, being 1,114,295 lbs., while the three spans of American steel weigh 3,330,172 lbs. The plate girder weighs 41,340 lbs., making the entire weight of iron and steel in the superstructure 4,485,807 lbs.

The trusses are proportioned to carry a moving load of 3,000 lbs. per lineal foot, but in calculating the effects of a moving load the portion of any strain in excess of that which would have been produced by a uniform load of equal amount was taken on a basis of 5,000 lbs. per foot. The top lateral system is proportioned to resist a wind pressure of 300 lbs. per lineal foot, and the bottom lateral system 500 lbs. per lineal foot. The floor system was designed for a uniform load of 6,000 lbs. per lineal foot.

The compressive strain in the top chord is limited to 14,000 lbs. per square inch of balanced section. The tensile strain in the bottom chord is limited to 13,000 lbs. per square inch, and that in the web members is kept somewhat lower.

The spans were erected in a remarkably short time, as is shown by the following statement. The east approach girder was placed November 22, 1888. In the through span I–II, the first iron was placed August 4, 1888, and the span swung August 9; in through span II–III the first iron was placed September 11, 1888, and the span swung September 17; in through span III–IV the first iron was placed October 20, 1888, and the span swung October 26; through span IV–V the first iron was placed November 13, 1888, and the span swung November 18.

The timber floor was put on by the Company's men working under the direction of the Resident Engineer, and the painting was done in the same way.

In one respect this bridge differs from other bridges over the Missouri. The piers are not founded on rock or is there any available rock to be found in the location. The bluffs east of the river rest on a prealluvial gravel which extends under the river, and the piers are founded in this gravel to a depth of 50 ft. below the alluvial deposit—that is, the piers are not founded in the deposit made by the river, but in an entirely different material which is permanent in character, and is the same material which forms the foundation of the bluffs adjoining the river. This condition of things required peculiar arrangements for the substructure of the bridge.

This substructure comprises a small abutment at the east end and five piers, which are numbered from east to west. Pier I has a pile foundation, and the other four are founded on pneumatic caissons of the following dimensions: Pier II, 28 × 60 × 18 ft.; pier III, 28 × 60 × 18 ft.; pier IV, 28 × 60 × 18 ft.; pier V, 23 × 50 × 15 ft. The caissons are built of pine timber with oak sills and iron cutting edges planked with two thicknesses of 3 in. pine plank. The caissons are all surmounted by timber cribs, those of piers II, III and IV having the corners cut off so as to make them of octagonal section, and that on pier V being of rectangular section. The cribs are built of pine timber planked with one thickness of pine, the corners being plated with ⅜-in. iron. Both caissons and cribs were filled with Portland cement concrete.

The caissons were built in position on pile false-work and lowered on long screws to the bottom of the river. The pneumatic machinery was as set up on the east side of the river immediately north of the bridge line. In the spring of 1888 it was transferred to the west side of the river and set up there. A temporary pile bridge was built 50 ft. north of the bridge line, extending entirely across the river. A service track was laid across this bridge, and it was used for the handling of material and to carry the pipes leading air and water to the caissons. A year later a similar pile bridge was built from the west shore as far as pier IV.

Pier I is founded on piles which were driven in the excavation made on the shore at a considerable distance from the river. The piles were cut off at an even elevation and capped with two courses of 12 × 18-in. oak timber. The masonry was erected on top of this timber. This pier is 57 ft. in height, and at the top is 35 × 8 ft.

At pier No. II the caisson was sunk into place through the superficial deposit of sand, clay, gravel, and boulders to its final position on the bed gravel. The sinking occupied nearly six months, including delays caused by high water. The pier which stands on this caisson is 97 ft. 6 in. in total height of masonry.

At pier III the caisson was sunk through fine sand; then through a mass of mud, snags, gravel and boulders; then through a layer of coarse gravel, beneath which was clean coarse sand, the lower part of this layer being mixed with a constantly increasing amount of gravel. The work of sinking this caisson was delayed by the spring floods. The pier here is 95 ft. in height from the top of the timber crib.

At pier IV there was less delay in sinking the caisson, as most of the work was done in the summer time, and there was less delay by flood. The material through which the caisson was sunk was first fine sand, then coarse sand, gravel and mud, then a smaller sand with occasional boulders, then through a mixture of sand and clay, then through coarse sand and gravel, and finally through fine compact sand. The total height of the masonry of this pier from the top of the crib was 96 ft. 6 in.

The foundation of pier V, which was put in before that of pier IV, was a little delayed by high water, and presented some difficulties, owing to the greater depth of water in the channel and the material through which it had to pass, which was first a soft blue mud followed by the same mud containing more or less sand, below which was a layer of 3 ft. of clean sand; below this again was coarse gravel interspersed with layers of clay, then coarse sand again followed by more blue clay, which continued to the bottom of the foundation. Much material was found here which could not be pumped, and clay-hoists had to be used. The height of this pier from the top of the crib was 50 ft. 2 in.

The dimension work of the five piers which are exposed to frost is of granite, quarried at Morton, Minn., and the remainder of the work is of limestone from Mankato,

Minn. The abutment at the east end of the bridge is a small piece of limestone masonry.

The amount of masonry and concrete in the bridge is as follows:

| | Masonry. | Concrete. |
|---|---|---|
| Pier I | 778.79 cub. yds. | .... |
| Pier II | 1,791.48 " " | 1,915.44 cub. yds. |
| Pier III | 1,749.27 " " | 1,879.35 " " |
| Pier IV | 1,781.06 " " | 1,879.35 " " |
| Pier V | 817.92 " " | 1,489.03 " " |
| East abutment | 71.69 " " | 18.37 " " |
| Total | 6,990.21 " " | 7,181.54 " " |
| Total masonry and concrete | | 14,171.75 " " |

The bridge and its approaches are owned by the Sioux City Bridge Company, which is controlled by the Chicago & Northwestern Company. The east approach is 1.65 miles long from its connection with the main line of the Chicago, St. Paul, Minneapolis & Omaha track to the east end of the bridge. The west approach is 1.92 miles long from pier V to its connection with the Chicago, St. Paul, Minneapolis & Omaha track in the bottom land west of the river. The Sioux City Bridge Company also owns a second connecting track 0.18 miles long, used in reaching the Sioux City passenger station, so that the total mileage owned by the Company is 4.04 miles.

A considerable amount of riprapping was done around the several piers. The only rectification done consisted in building a small piece of dyke above the bridge on the west side, which was put in to control the river in case the channel should again be thrown by some temporary disturbances toward the west side of the river.

The work was undertaken by Mr. George S. Morison as Chief Engineer. On May 1, 1887, a professional partnership for two years was formed between Mr. Morison and Mr. E. L. Corthell. After the termination of this partnership on April 30, 1889, Mr. Morison remained Chief Engineer in charge. Mr. E. Gerber was Resident Engineer, assisted by Messrs. A. B. Corthell, J. W. Freger, C. H. Mayne, and Andrew Thompson.

The contractors for the masonry were T. Saulpaugh & Company; for the superstructure, The Union Bridge Company; for the erection, Baird Brothers, Mr. George Buchan being Superintendent of erection; for the earthwork, McNamara & McCarthy, and for the trestle work, Wakefield & Hill.

The sub-contracts were let in August, 1887; the erection of the last span was completed November 20, 1888; the first train crossed the bridge on November 20, 1888, and on December 5 the bridge was formally tested. Its entire charge was turned over to the Operating Department of the Chicago, St. Paul, Minneapolis & Omaha on August 8, 1889, and it has since been in regular use.

## ARMY ORDNANCE NOTES.

THE War Department has already prepared for issue proposals for materials to be used for the manufacture of guns under provisions of the Fortifications act, to take effect with the new fiscal year, as follows:

For 25 sets of forgings for steel field guns of 8.2-in. caliber; for 16 sets of forgings for steel field mortars of 3.6-in. caliber, and for 16 steel carriages for the same; for steel forgings for 8, 10 and 12-in. rifled coast-defense guns; for 8, 10 and 12-in. armor-piercing projectiles; for excavations and iron work at the new south wing of the Watervliet Gun Factory. For the large coast-defense guns above referred to Congress appropriated $800,000 for the procurement of the necessary forgings, and the material will be assembled at the Watervliet factory and the finished guns turned out. The 3 6-in. mortars mark a new departure in military field operations. They are intended to replace the small cohorns which are used in trenches for shelling an enemy behind earthworks or like defenses and out of the direct fire of field guns. Their range is nearly three times as great as the cohorn smooth-bore mortars, the projectile is more than twice as heavy, and great accuracy of fire is obtainable. The weight of the piece is about 525 lbs., so that it can be easily transported in a wagon or moved about by men in the trenches. The armor-piercing projectiles are to be manufactured by a domestic concern, but upon specifications that will secure the use of some one of the modern European patented processes. For their manufacture an appropriation of $100,000 will be available. The work of construction at Watervliet, for which advertisements have so far been prepared, will, it is estimated, cost about $75,000.

Bids were recently opened in the Ordnance Office of the War Department for the construction of 25 carriages for 12-in. breech-loading rifled mortars. Only two bids were received. The Morgan Machine Works, of Alliance, O., offered to build eight carriages, complete, for $65,405, delivering the first one within 18 weeks and the other seven at the rate of one every six weeks after, or 25 carriages for $7,725 each, the delivery of the first eight to be as above, and the remaining 17 at the rate of one every three weeks. The Builders' Iron Foundry of Providence, R. I., offered to build eight carriages for $14,000 each, or ten for $130,000, and each additional carriage for $12,500, delivery of the first carriage to be in one year, the second four months later, and the third three months later, and the remainder at intervals of two months each. The bid of the Morgan Iron Works is by far the lowest and the delivery much the more prompt, but the Builders' Company claim to control the American right to a foreign patent, which they assert will prevent any one else from building in this country such carriages as the Government wants.

## CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

### CHEMISTRY APPLIED TO RAILROADS.
### XVI.—PAINT SPECIFICATIONS.

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.



(*Continued from page* 177.)

WE had intended to give in this article a further discussion of "How to Design a Paint," comprehending in the discussion the liquid used and the proportions of pigment and liquid, but we find a little further experimentation necessary in order to decide one or two points involved, and are compelled to postpone the conclusion of the subject "How to Design a Paint," until a subsequent article.

In this article we will give two of the specifications which have thus far been issued for different paints by the Pennsylvania Railroad Company, with the reasons why for each of the specifications.

The first paint specifications were for the material used for cabin car color. These specifications have been re-

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION of special value in indicating the true character of the materials they must use and buy.

vised twice, the form given below being the latest issue, as follows:

PENNSYLVANIA RAILROAD COMPANY.

*Motive Power Department.*

*Specifications for Cabin Car Color.*

The standard cabin car color is the pigment known as scarlet lead chromate. It is always purchased dry.

The material desired under this specification is the basic chromate of lead (PbCrO, PbO), rendered brilliant by treatment with sulphuric acid, and as free as possible from all other substances. The theoretical composition of basic lead chromate is nearly 59.20 per cent. of normal lead chromate, and 40 80 per cent. of lead oxide, but in the commercial article it is found that a portion of the sulphuric acid added to brighten the color remains in combination apparently with the normal lead chromate, slightly increasing the percentage of this constituent. The sulphuric acid thus combined should not exceed one-half of one per cent.

Samples showing standard shade will be furnished on application, and shipments must not be less brilliant than sample. The comparison of sample from shipment, with the standard shade, may be made either dry or by mixing both samples with oil.

Shipments of cabin car color will not be accepted which:

1. Contain barytes or any other adulterant.
2. Show on analysis less than 57 per cent. or more than 60 per cent. of normal lead chromate, including the sulphuric acid combined as above stated.
3. Show on analysis less than 38 per cent. or more than 42 per cent. of lead oxide, in addition to lead oxide in the normal lead chromate.
4. Vary from standard shade.

THEODORE N. ELY,
*General Superintendent Motive Power.*

*Office of General Superintendent Motive Power, Altoona, Pa., February* 18, 1891.

Considerable discussion arose when these specifications were first prepared, as to what sort of pigment should be used for cabin car color. It is well known that the cabin car forms the rear end of every freight train, and is the car in which the crew stay and protect themselves from the weather, etc., when they are not at work somewhere along the train. So far as the color of the car is concerned, this principle is involved, namely, that the rear end of every freight train is subject to danger from any succeeding train, and it therefore becomes of the utmost importance that the rear end should be properly protected. It is, of course, well known that when a freight train or any other train stops on the track, the rear brakeman goes back a proper distance to prevent any succeeding train from running into the one which is standing. It is also well known by those who are at all familiar with railroad operation, that the rear end of every train is protected in the night-time by signal lamps, and in the daytime by flags. In order, however, to make the protection as complete as possible, it was decided, and is the principle which is used everywhere, to make the cabin car itself a danger signal. It is well known that red is the color used on all railroads for the danger signal, and consequently the cabin cars are painted red. In order to make this red as prominent and pronounced as possible, and to have it attract as much attention as possible, it must be a bright one. A dull red or a brown would not be so marked or prominent. In looking over the pigments which could be used for this purpose, a number of considerations had to be taken into account. The iron oxides were too dull. Red lead was too much of an orange. Either of these brightened up with any of the aniline colors or the lakes were too fugitive, and practically the choice was narrowed down ultimately between genuine vermilion and scarlet lead chromate. The difference in price largely decided the choice of scarlet lead chromate as cabin car color.

Since this material was adopted as standard, a number of new pigments have come forward which are extremely brilliant in color, and which are made apparently by precipitating some of the coal tar colors with lead salts. We have examined some six or eight of these which appear in the market under various fanciful names, and have also made exposures of a number of them. We have not succeeded yet in finding any which had even a moderate permanence under exposure. They all fade rapidly, and with now some five or six years' experience, we know of nothing better for a good, fairly permanent bright red, than scarlet lead chromate.

It will be noted that the material is bought dry. The reason for this is that this pigment does not stand grinding. When ground at all fine the color is largely destroyed, the brilliant red being largely replaced by a yellow. The material can be obtained in the market mixed in japan, or oil; but we prefer to buy it dry. When received it is mixed with oil and japan by simply stirring, and not by grinding.

The pigment, when first made, is very dull, and after precipitation and washing, a treatment with sulphuric acid is essential in order to bring out the brilliant shade. The chemistry of this process or the change produced by this treatment is not understood—at least, we have never succeeded in finding any explanation of why sulphuric acid renders this material so much more brilliant in color than when first precipitated. The fact remains.

In view of the theoretical constitution of the pigment, it would seem that the limits of the specifications ought to be sufficiently wide, so that no difficulties would arise in securing material in the market which would fill the requirements; but some manufacturers almost universally fail to meet the specifications. We have had many shipments which did not contain enough of the normal lead chromate, and even some which were deficient in lead oxide. This is due largely to method of manufacture, but in general we have had very little difficulty in securing the pigment.

The method of analysis consists in treating a weighed sample with acetic acid and heat, which leaves the normal lead chromate undissolved. This is then filtered into a weighed Gooch crucible, and the amount obtained by weight after drying. The acetic acid solution contains the oxide of lead, and this is usually determined by titration with standard bichromate of potash. These figures should sum up, according to the specifications, 95 per cent., leaving only 5 per cent. for other substances. If this results, there is small probability of any adulterating material being used. A test, however, is always made by dissolving a fresh sample of the material in muriatic acid in presence of alcohol, which leaves barytes undissolved. The amount, if any is present, can be determined by filtration and subsequent weight.

Some experiments have been made to see whether scarlet lead chromate would bear dilution with inert material, in accordance with the principles which have been enunciated a number of times in previous articles of this series. Our experience with this pigment has not proven very satisfactory. The coloring and covering power of scarlet lead chromate is so meager that it does not seem to work well with any inert material which we have yet discovered. It is fair to say that 10 per cent. of barytes added does not interfere to any serious extent, but a 10 per cent. addition of inert material is so small that it is hardly worth while to attempt to use it. Such material—namely, scarlet lead chromate containing 10 per cent. of barytes—can be obtained in the market at a slightly lower price. As high as 50 per cent. of inert material affects the shade quite considerably. We are hardly satisfied yet, and our experiments are still in progress; but, so far as we have gotten, this pigment is apparently one of the few which will not bear much admixture with inert material.

The next specifications historically made on the Pennsylvania Railroad for paint materials were for freight car color. The use of freight car color on the road is very extensive, very large amounts of it being used every year, both for new work and for repairs. The specifications at present in force are the second revision. The first draft remained in force about one year, the second about one year, and the third, which is at present in force, about two and a half years. It seems probable that a new revision will be made possibly within the coming year, the principal probable change being to diminish the amount of oxide of iron required in the pigment. It is of course understood that, as knowledge increases on any given subject, the specifications are modified to meet the increase in knowledge, the constant aim being to secure the best pos-

sible results for the least money. The specifications are as follows :

PENNSYLVANIA RAILROAD COMPANY.

*Motive Power Department.*

*Specifications for Freight Car Color.*

Freight car color will be bought in the paste form, and the paste must contain nothing but oil, pigment and moisture.

The proportions of oil and pigment must be as nearly as possible as follows :

Pigment, 75 per cent. by weight.

Oil, 25 per cent. by weight.

The oil must be pure raw linseed-oil, well clarified by settling and age. New process oil is preferred.

The pigment desired contains not over one-half per cent. of hygroscopic moisture, and has the following composition :

Sesquioxide of iron, 50 per cent. by weight.

Fully hydrated sulphate of lime or gypsum, 45 per cent. by weight.

Carbonate of lime, 5 per cent. by weight.

Samples of standard pigment showing shade will be furnished, and shipments will be required to conform strictly to standard. The shade of paint being affected by the grinding, the P. R. R. standard shade is that given by the dry sample sent, mixed with the proper amount of oil and ground, or better rubbed up in a small mortar with pestle until the paste will pass P. R. R. test for fine grinding. It is best to use fresh samples of the dry pigment for each day's testing. The comparison should always be made with the fresh material, and never with the paint after it has become dry. The comparison is easiest made by putting a small hillock of the standard paste and of that to be compared near each other on glass, and then laying another piece of glass on the two hillocks, and pressing them together until the two samples unite. The line where the two samples unite is clearly marked if they are not the same shade.

The paste must be so finely ground that when a sample of it is mixed with half its weight of pure raw linseed-oil, and a small amount of the mixture placed on a piece of dry glass, and the glass placed vertical, there will be no separation of the oil from the pigment for at least half an hour. The temperature affects this test, and it should always be made at 70° Fahrenheit. The sample under test runs down the glass in a narrow stream when it is placed vertical, and it is sufficient if the oil and pigment do not separate for an inch down from the top of the test.

Shipments will not be accepted which :

1. Contain less than 23 per cent. or more than 27 per cent. of oil.

2. Contain more than 2 per cent. of volatile matter, the oil being dried at 250° Fahrenheit, and the pigment dried in air not saturated with moisture at from 60° to 90° Fahrenheit.

3. Contain impure or boiled linseed-oil.

4. Contain in the pigment sulphate of lime not fully hydrated, less than 40 per cent. of sesquioxide of iron, less than 2 per cent. or more than 5 per cent. carbonate of lime, or have present any barytes, aniline colors, lakes or any other organic coloring matter, or any caustic substances, or any makeweight or inert material, which is less opaque than sulphate of lime.

5. Vary from shade.

6. Are not ground finely enough.

7. Are a liver, or so stiff when received that they will not readily mix for spreading.

THEODORE N. ELY,
*General Superintendent Motive Power.*

*Office of General Superintendent Motive Power, Altoona, Pa., November* 9, 1888.

Taking up the points in the specifications in order as they come, we will say, the reason why the material is bought in the paste form is that the grinding of the paint is an art by itself, and requires a good plant and skill. It is, therefore, deemed advisable to put this work into the hands of parties who are fitted for it, instead of the company attempting to do this work itself. The mixing of paint for use, however, is wisely and properly varied by the conditions under which the paint is used ; and accordingly the paint is bought in the paste form rather than ready mixed, the company leaving to its own employés the duty of proper mixing. It will be observed that only pigment, oil and moisture are allowed in the paste. The reason why japan or other materials are not allowed to be present is because japans differ very greatly with different makers, and consequently two batches of paint furnished the same shop by different makers would require different treatment in order to get the same results if japan was allowed to be present. On the other hand, nothing but pure raw linseed-oil being present, each master painter can use his own experience and judgment in the mixing, so as to obtain the best results. The quantities being definitely proportioned for the ingredients, gives the proper drying, and the proper results in service. The question of the amount of pigment and liquid will not be discussed in this article, since it properly belongs to the next one. We will only say here, therefore, that the percentages by weight given in these specifications are those which experience has indicated are necessary in order to secure a good paste.

The reason for preferring new process oil, which, as is well known, is made by treating the seeds with a solvent rather than by pressure alone, is that the new process oil is apt to contain less vegetable albumen and other impurities than from freshly made old process oil. It is not believed that linseed-oil obtained from the seeds by pressure alone and allowed to stand sufficiently long is not as good as new process oil, but there is a tendency in the trade to sell the oil soon after it is removed from the seeds ; and we have many times found evidence of vegetable matter in the oil made by the old pressure process, which is not characteristic of freshly made new process oil.

The proportions of the various constituents of the pigment were at first decided on arbitrarily, as, when these specifications were first prepared, we had very little practical experience upon a good many points which have since been made the subject of definite test and experimentation. The amount of oxide of iron required in these specifications is probably higher than there is any need of, and, as hinted at above, it is probable that the next revision will diminish the amount required. Moreover, experiments indicate that abundantly good covering power is obtained with as low, perhaps, as 20 or 25 per cent. of the weight of the pigment oxide of iron, especially if the paint is finely ground. In reality oxide of iron is one of the very best of the cheap pigments. Its covering power is very high ; its durability, so far as our experience goes, very great, and its price very low. Of course there are very wide differences in the shades of the different oxides, most of which are made by igniting copperas or igniting ochres. Some of these are of a rather disagreeable purplish red color ; but a good oxide of iron of pleasing color is certainly a very valuable pigment, and we really know of none that is superior to it, all things considered. Some questions have arisen as to whether the oxide of iron is durable in the presence of oil, especially the oxides made by the ignition of the sulphate or copperas. It is on record in the books that it is believed oxide of iron, if it contains hydrated oxide, or contains free sulphuric acid, will deteriorate with moderate rapidity. Our own experience has not confirmed this statement, and we really have seen no positive information which points in the direction that oxide of iron is not a very durable pigment.

The reason why sulphate of lime is used as an inert material has already been discussed in the article preceding this one. The reason for a small amount of carbonate of lime is found in the fact that, as has already been hinted at, some of the iron pigments made from the ignited sulphate contain free sulphuric acid, the heat of ignition not being sufficient to drive it all off. We have made positive experiments which show that the presence of a small amount of free sulphuric acid mixed with the iron oxide retards the drying very greatly. We accordingly mix a small amount of carbonate of lime with the pigment, which satisfies the sulphuric acid, forming sulphate of lime, and we have found that this small amount of carbonate of lime facilitates drying very greatly.

A number of manufacturers have suggested the use of carbonate of lime or whiting in place of sulphate of lime in our freight car color as inert material. The reasons for preferring sulphate over carbonate have already been given ; but we will say that we have experiments in progress to set this question finally at rest. Boards have been painted and exposed, in which the inert material is largely carbonate of lime, and also companion boards, in which the inert material is largely sulphate of lime. We hope within a year or two to have conclusions on this point. At present we are unable to say anything more positive than has previously been said.

The question of shade has caused no small amount of difficulty, and it is very common for manufacturers to remark, that our shade is a very difficult one to match. Our own experience is that the same remark may be made of every other shade, or, in other words, all shades are extremely difficult to match. The whole question of making duplicate shipments of exactly the same shade is extremely difficult; indeed, a very large number of conditions quite seriously affect the shade. Starting with the same paste, four or five different shades can be obtained in the finished work by using different percentages of japan and turpentine and oil in different portions of the paste, also by neglecting to stir the pot of paint during the application frequently enough, and, indeed, by allowing the mixed paint to stand a day or two and become skinned over, the shade is changed. It will be noted that the specifications call attention to the fact that the fineness of the grinding seriously affects the shade, and also to the fact that material which has been used one day should not be used the next in making the test. We have found by experience that both of these conditions quite seriously affect the standard shade. In the latter case, the shade is changed, due to the changed proportions of liquid and pigment, and also certain constituents seem to be removed more readily than others by the skin which is taken off. So positive are we of the difficulty connected with the exact matching of shades, that we do not hope to secure in successive shipments exact matches. It is astonishing many times how close the match is; but unless approximately the same pigments and the same proportions of inert materials are used by different parties, and by the same parties in different shipments, the shades will hardly ever be exactly the same. We accordingly allow ourselves a little lee-way in comparing shipments with the standard, rejecting if the shipment shows a marked difference from the standard. Considerable time has been spent in trying to devise some method of establishing limits of shade, outside of which shipments would not be accepted; but no feasible method has yet been obtained for making such comparisons, as we have not yet succeeded in getting any way of measuring how much one shade differs from another.

Our method of comparing shades has been criticised somewhat, many parties claiming that it is too severe to bring the two side by side under glass. We are quite well aware that this plan gives very close and accurate results; but we do not know of any better method than the one proposed. The whole question of shade is not free from difficulties, and, as many manufacturers have found, it is not a simple matter to make a shipment of paint look like a given sample. Some authorities on the subject of shade regard the matching of shade as a special gift, and that it is not at all possible for every one either to express an opinion on shades after they are placed side by side, or especially that all are not able to make such combinations as will produce the same shade.

The question of fine grinding was one which caused a good deal of study. At first we regarded the fineness of the pigment as the only consideration which should be studied; and accordingly, in our first specifications, a test as to whether the pigment would go through a certain mesh sieve was all the test we used for grinding. We found, however, that it was quite possible to have the pigment fine enough, and still, with a good mixer, to mix the paint so that it would pass this test for fineness without having gone through the mill at all. We accordingly tried to see if some test could not be devised which would decide positively whether the material had been ground or not. The test proposed, it will be observed, is based on the intimate mixture of the oil and pigment, the pigment being fine enough, so that practically the oil holds it up. It is well known that in a mixture of solid and fluid the tendency of the two to remain together is largely a function of the fineness of the solid. Familiar examples of this are dust in such a fine state of division that it floats in the air, and also clay or other substances in such a fine state of division that they are permanently sustained in water, keeping it cloudy or muddy for weeks. The test has thus far worked very satisfactorily, and with one or two possibilities of evasion seems to cover the ground very well. It is quite evident to any one that anything which adds to the viscosity of the oil would enable a coarser ground paint to pass the test. We of course are constantly on the lookout for anything of this kind. A small amount of caustic soda added to the oil, making a little bit of soap, would of course evade the test to a certain extent. This we check up by examining for soap in the mixed paint. The addition of small amounts of japan would also have the same tendency, and also the addition of small amounts of varnish or any other liquid mixed with the oil which would make it more viscous. These difficulties we are quite well aware may arise, and are constantly on the lookout for them. Those who have never experimented with the test will be astonished to see how readily the oil separates from the pigment if the material is at all coarse. It should be stated still further that if the pigment is of greater specific gravity than the standard pigment used for this paint, the tendency to separate will increase, so that the test as arranged for the standard freight car color is not universally applicable to all pigments. We think the principle is applicable, and it is only necessary to modify the conditions of the amount of oil added to the paste, or other conditions, in order to have the test universally applicable to the grinding of all paints in the paste form. Quite a large amount of water mixed with the oil, forming an emulsion, has the effect of rendering the oil more viscous, and for this reason, as well as for commercial reasons, it will be noted that the amount of volatile material, principally, of course, water, allowed in a shipment, is limited to 2 per cent.

The limits of oil allowed in the specifications—about 4 per cent.—are sufficiently wide, so far as our experience goes, so that shipments should never be rejected on account of having not enough oil, or too much. The question of the livering of the paint is one which is quite extensive, and we will therefore not take it up now, and closely connected with this is the point mentioned in the specifications of hydration of the sulphate of lime. We hope to give our experience with the livering of paint in a separate article. The reasons why for the causes which lead to the rejection of a shipment other than those mentioned are perhaps clearly evident from what has already been said.

In the next article we hope to finish the subject of "How to Design a Paint," and this will be followed by another, giving, if possible, in one article, our experience with the livering of paint and our specifications for Tuscan red.

(TO BE CONTINUED.)

## THE PATENT CENTENNIAL.

THE centennial celebration of the establishment of the American Patent System began in Washington, according to the programme, on April 8, when the first public meeting took place in the Lincoln Music Hall. The President of the United States presided; upon the platform with him were the Secretary of the Interior, the Chief Justice of the United States, the Commissioner of Patents and a number of other distinguished gentlemen. The President made a brief opening address, and was followed by the Commissioner of Patents in a long and interesting speech on the Patent System. The next address was made by Senator O. H. Platt, Chairman of the Senate Committee on Patents, who gave a number of illustrations of the progress made in the past century, and was followed by Labor Commissioner Carroll D. Wright.

In the evening a special reception to inventors and manufacturers was given at the Patent Office by the Secretary of the Interior and the Commissioner of Patents. A large number of gentlemen and ladies were present, and the reception was much enjoyed.

On April 9 public meetings were held in the afternoon and evening, the first one being presided over by Hon. Frederick Fraley of Philadelphia, and the second by Professor S. P. Langley, Secretary of the Smithsonian Institution. Among the speakers were Mr. Edward Atkinson, Judge Samuel Blatchford, and Mr. O. Chanute, President of the American Society of Civil Engineers. Mr. Chanute referred to the progress in aerial navigation, and stated that several men of ability were now at work on a prob-

lem, the possibility being that practicable machinery would before long be in actual use.

On April 10, the day was given up to an excursion to Mt. Vernon, where an address was made by Dr. Toner, of Washington. This was the special anniversary day, being the hundredth anniversary of the signing of the first American patent. In the evening another public meeting was held, at which Professor Alexander Graham Bell presided. Addresses were made by Professor Gray, Dr. Brackett, and others.

This necessarily brief account can give but a few of the prominent features of the celebration. The Executive Committee and the Local Committee made admirable arrangements for the reception of visitors and the celebration was much enjoyed by all present, among the special features being the reception at the White House, that at the Patent Office, and the excursion to Mt. Vernon.

AMERICAN ASSOCIATION OF INVENTORS AND MANUFACTURERS.

Part of the proceedings at the Patent Centennial included the formation of a permanent association to care for the interests of inventors and manufacturers. A National Committee had been appointed, representing all the States, and the first meeting was held April 8, which was chiefly devoted to preliminary discussion. A special committee was appointed and a general meeting of inventors and manufacturers was called, which was held in the morning of April 9, at which a committee was prepared to submit a plan of organization.

On April 10 another meeting was held, at which this committee submitted a constitution and by-laws for the proposed Association, the objects of which was stated as follows:

"The promotion of progress in the useful arts; the diffusion of practical, scientific, and legal information respecting inventions; the encouragement of favorable and the discouragement of unfavorable laws respecting property in patents; the co-operation of foreign inventors for reciprocal regulations under foreign patent systems, and the proper, just and adequate protection of the rights of American inventors authorized by the Constitution of the United States."

The report of the committee was thoroughly discussed. Some changes were made in the proposed constitution, and it was finally adopted as amended. The organization was completed by electing the following officers: President, Dr. R. J. Gatling, Hartford, Conn. Vice-Presidents, Gardner G. Hubbard, Washington; Thomas W. Shaw, Philadelphia; William A. Anthony, Manchester, Conn.; Benjamin Butterworth, Cincinnati. Secretary, Professor J. Elfreth Watkins, Washington. Treasurer, Marvin C. Stone, Washington. Directors, Charles F. Brush, Cleveland, O.; Professor R. H. Thurston, Ithaca, N. Y.; Professor Otis T. Mason, Washington; Oberlin Smith, Bridgeton, N. J.; David S. Weems, Baltimore; John H. Bartlett, Roanoke, Va.; F. E. Sickles, St. Louis; John Y. Smith, Pittsburgh, Pa.; David W. Smyth, Manchester, N. H.; R. S. Munger, Birmingham, Ala. The constitution, etc., will be published later.

### Foreign Naval Notes.

THE results obtained in the official trials of the Fiske range finder, both in France and Italy, were most satisfactory to the commissions of officers who tested it. In France the trials were held on board *Le Formidable*, the flagship of the Mediterranean fleet, and they comprised a careful series of observations taken both under way and at anchor at Cannes and Toulon. In Italy the range finder was mounted and tried on the old *Terrible*. The results in both cases showed very small percentages of error, notwithstanding the restricted base lines on the vessels used.

THE FRENCH CRUISER "SFAX."

The *Rainbow*, the second of three second-class cruisers which are being built for the British Government by Messrs. Palmer & Company, was successfully launched early in April. She has a displacement of 3,400 tons; length, 300 ft.; breadth, 43 ft., and draft, 16 ft. 6 in. Her engines will develop 9,000 H.P., sufficient to propel her under natural draft at a speed of 18 knots. Her armament will consist of two 6 in. and six 4.7-in. rifled breech-loading guns, and nine quick-firing guns.

The French Navy Department has asked for appropriations for next year amounting to $45,532,858, an increase of $667,926 over the present year.

The trials of the Elswick 6-in. quick-firing gun and mounting were completed on board the *Kite*, at Portsmouth, England, last week. Two hundred and sixty rounds have now been fired from this gun on the same mounting, and there does not appear to be the slightest sign of wear in any of the working parts. The rapidity and ease with which one man can elevate and train the gun and mountings, the weight of which complete is 17 tons, is surprising; and it says a great deal for the crew, as well as for the gun, mounting, and ammunition, that 260 rounds have been fired, almost all against time, without the slightest hitch occurring. It should also be specially noted that, of this last series of 100 rounds, 80 cartridges were fired for the second time. But this feature has been brought out, perhaps, more prominently by trials which have been carried out by a similar 6-in. quick-firing gun by the military authorities at Shoeburyness, where cartridges have been fired as many as 16 times.

*Engineering* thinks that these exhaustive trials, giving such successful results, should convince others besides the English Government of the efficiency of the Elswick system.

A FRENCH CRUISER.

The accompanying illustration, from *Le Yacht*, shows the French cruiser *Sfax*, which is considered one of the finest vessels of her class in the French Navy. She is built of steel, and was launched in 1884.

The *Sfax* is 288.6 ft. long, 49.2 ft. beam, 25 ft. draft, and 4,500 tons displacement. Her compound engines drive twin-screws, and have developed 6,522 H.P., giving the ship a speed of 16.7 knots per hour.

The chief protection consists of an armored deck of steel, 1.6 in. thick, extending the whole length of the ship. The armament consists of six 16-cm. (6.3-in.) guns, ten 14-cm. (5.5-in.) guns, 10 revolving cannon, and five torpedo-tubes.

Like most French cruisers, the *Sfax* is heavily masted, and can carry a considerable area of sails. Her crew consists of 473 officers and men.

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## THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.



(*Continued from page* 181.)

### CHAPTER XI.

### CURVES.

ARCS OF CIRCLES.

The circles and portions of circles thus far described have been of such dimensions and located in such positions, that there has been no difficulty in drawing them with a pair of ordinary compasses. It happens, however, at times that the center

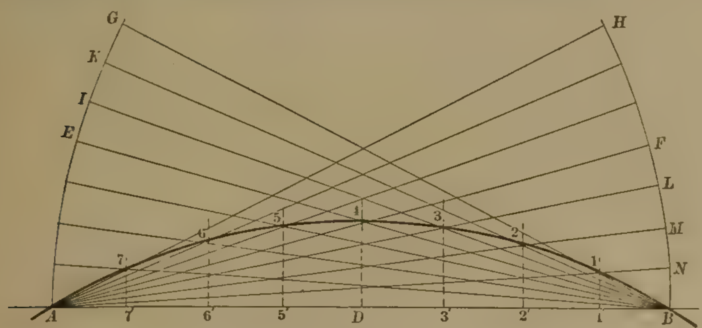



Fig. 241.

of an arc of a circle is inaccessible, or the radius is so long that it is impracticable to draw an arc with the instrument named, or even with a beam compass. We may, for example, have :

Problem 65. *To describe a circle passing through three given points, when the center is not available.*

* *First Method.*—Let *A* 4 and *B*, fig 241, be the three points. From *A* as a center with *A B* as a radius describe an arc, *B H*, and from *B*, with the same radius, describe *A G*. Through the third point 4 draw the lines *A* 4 *F* and *B* 4 *E*, intersecting the arcs at *E* and *F*. Divide *A E* and *B F* into any number of equal parts, and set off a series of equal parts of the same length on the upper portions *E G* and *F H* of the arcs beyond the points *E* and *F*. Draw straight lines *B I*, *B K* and *B G* to the divisions in *A G*; and *A L*, *A M*, *A N*, etc., to the division on *B H*; the successive intersections, 1, 2, and 3, of these lines are points in the circle required, between *B* and 4. Similar points between *A* and 4 may be laid out in the same way, and the required curve, *A* 4 *B*, may then be drawn by hand with a pencil through the points thus laid out. In inking in this curve, the student will find that it is very difficult to draw it with the precision and smoothness that is possible when drawing instruments are used, and few draftsmen ever acquire the skill which will enable them to draw curves by hand with the accuracy and definiteness which is required to make a drawing look neat and workmanly. When instruments cannot be used it is therefore best to make or use a "*templet*." As this will be essential in many such cases, the method of making such an implement will be described.

The student should provide himself with a piece of straight-grained white pine, clear of sap of resin, and about $\frac{3}{16}$ in. thick, planed smooth on both sides and on one edge, so as to make the latter straight. After the points of the curve have been laid down on paper, draw the line *A B* on the piece of wood at a little distance from and parallel to its straight edge. The points of the curve may then be laid out on the wood, as already described, or it can be done more conveniently by first drawing on the paper "*ordinates*" or perpendicular lines, 1 1′, 2 2′ 3 3′, etc., from the points 1, 2, 3, etc., to *A B*. These should be laid off with a pair of dividers from the perpendicular *D* 4, drawn on the wood midway between *A* and *B*. The distance 1′ 1, 2′ 2, 3′ 3, etc., should then be transferred from the paper to the ordinates on the wood, and the curve can be drawn with a pencil as accurately as possible through the points 1, 2, 3, etc., thus laid down. Then with a sharp knife cut away the wood from the outside of the curve *near* to the line required, and bring it exactly up to the mark by means of a fine file, or fine sandpaper, or both. A half-round file is best for this, as one side of it can be used to finish up concave curves. In using the sandpaper, lay a smooth sheet or piece of it on the drawing-board, and rub the edge of the templet on the paper, being careful to hold the slip of wood so that its sides will be perpendicular to the surface of the paper. This templet may then be used as a ruler for drawing the curve with a pen.

A great variety of templets or "*curves*," as they are called, made of hard rubber or wood, are now sold by the dealers in drawing instruments and materials. These are intended for drawing different objects, such as ships, railroad curves, etc. For drawing the latter, sets of circular "curves," of varying radii, are sold, which all mechanical draftsmen will find very useful if they can afford to supply themselves with them. The cost of a set of 10 of these is given in the catalogue of a prominent dealer at \$7.75 ; sets of 17, \$13.25 ; and 40, \$28.

*Second Method for the solution of* Problem 65.—Let *A* 4 *B*, fig. 242 be the given points ; draw *A B*, *A* 4, *D* 4 and *e f* through 4 and parallel to *A B*. Divide *A* 4 into a number of equal parts, *a*, *b*, *c*, 4, and from 4 describe arcs through these points to meet *e f*. Divide the arc *A e* into the same number of equal parts, and draw straight lines from 4 to the points of division. The intersection of these lines successively with the arcs 1, 2, 3, etc., are points in the circle, which may be filled as before.* For inking the curve in, a templet should be constructed as described above.

*Third Method.*—Let *A* 4 *B*, fig. 243, be the required points. Draw the chord *A D B* and *h* 4 *i* through 4 and parallel to *A D B*. Bisect *A D B* at *D* and erect the perpendicular *D* 4 ; join *A* 4 and *B* 4 ; draw *A h* perpendicular to *A* 4 and *B i* perpendicular to *B* 4. Erect also *A n* and *B n* perpendicular to *A D B* ; divide *A D B* and *h i* into any number of equal parts—in this case eight—and draw the lines *d d′*, *e e′*, *f f′*, etc., and divide the lines *A n*, *B n* each into half the number of equal parts in *A D B* ; draw lines from 4 to each division in the lines *A n* and *B n*, and the points of intersection, 1, 2, 3, 4, etc., with the former lines, will be points in the required curve.†

Problem 66. *To describe an arc or segment* ‡ *of a circle of a large radius.*

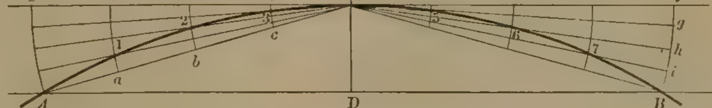



Fig. 242.

Let *d c*, fig. 244, be the chord of the arc and *b o* its rise or versed sine. Then with wood or other suitable material con-

* The two following solutions are from "The Engineer's and Mechanic's Drawing Book."

* The second method is not perfectly true, but sufficiently so for arcs less than one-fourth of a circle. When the middle point is equally distant from the extremes, the vertical *C D* is the *rise* or *versed sine* of the arc. This problem is serviceable for setting out circular arcs of large radius, as for bridges of very great span, when the center is unavailable ; and for the outlines of bridge-beams, steam-engine beams, connecting-rods and the like.

† This and the following problem are from the "Engineer's and Mechanic's Pocket Book," by Charles H. Haswell.

‡ The word segment means a portion. A segment of a circle is a portion of a circle.

struct a triangle, *A b C*, of which the sides *A b* and *b C* are slightly longer than the chord *d c*, and whose apex, *b*, will coincide with the point *b* in the circle, and the points *d* and *c* will coincide with the sides *A b* and *b C*. At each end of the chord *d c* insert a pin, and at *b* attach a tracer (as a pencil or sharp point); move the triangle against the pins as guides, and the tracer will describe the arc required.

PROBLEM 67. *To lay out a circular curve by means of tangential angles.*

If from any point, *A*, fig. 245, on a line *A a*, equal angles *a A b*, *b A c*, *c A d*, etc., are laid off, and lines *A b*, *A c*, *A d*, etc., are drawn; then if with any distance, as *A* 1 for a chord, we step off from *A a*, point 1, on *A b*, and with the same chord lay off another point, 2, from 1 on *A c*, and if in a similar way the points 3, 4, 5, etc., are laid off on *A d*, *A e*, *A f*, etc., then these points will be situated in a circular curve, the radius of which depends upon the angles and the length of the chords. The curve will also be tangent to the straight line *A a* at *A*, the place of beginning. Consequently the angle *a A b* is called the "*tangential angle*," and as the others are all equal to it, they are also called tangential angles. This is one of the methods employed for laying off railroad curves, the angles being measured with instruments constructed for the purpose. Elaborate tables have been calculated, which give the radii of curves for given angles and chords. The following table has been calculated for a chord equal to 1, so that it can be used for any length of chord that may be employed. Thus 1 may represent one-eighth of an inch, one inch, one foot or one hundred feet; but if the chords are measured in fractions of an inch, inches, feet or hundreds of feet, the radii of the curves are also given in the same fractions, or in inches, feet or hundreds of feet.

In the first column the tangential angles are given, in the second the "*deflection angles*," which will be explained hereafter, and in the third the radii of curves laid off with such angles and chords = 1. Thus, in fig. 245 the tangential angles *a A b*, *b A c*, etc., are 5 degrees and the chords *A* 1, 1 2, 2 3, etc., are equal to ½ in.; consequently the radius of the curve is given in half inches, and is equal to $\frac{11.463}{2} = 5.731$ in. If the chord used had been an inch long, the radius of the curve, with tangential angles of 5 degrees, would have been equal to 11.463 in.; if the chord had been equal to 1 ft., the radius would be 11.463 ft. From the table, then, we can readily ascertain what the radius will be for any angle of deflection and any chord.

If for any reason—as happens very often in laying out railroad curves—a curve cannot be completed from one point, as *A*, then it can be continued from any other point, as 5, by extending the chord 5 6 to *j*, and laying off angles *j* 5 *k*, *k* 5 *l*, *l* 5 *m*, etc., from 5 *j*, and continuing as already explained; or a curve of greater or lesser radius may be drawn from 5, as may be desired.

PROBLEM 68. *To lay out a circular curve by means of deflection angles.*

Starting from *A*, fig. 246, on the line *A a*, lay off the tangential angle *a A b* and measure the chord *A* 1 as in the preceding problem. Then from 1 lay off an angle, *b* 1, *c* called the *deflection angle*, equal to twice *a A b*, the tangential angle, and measure the chord 1 2 on 1 *c*. Then 2 will be a second point in the curve. Proceed in the same way, and lay off deflection angles from the successive points 2, 3, 4, 5, etc., and measure the chords on the lines 2 *c*, 3 *d*, 4 *e*, etc., and the points thus established will be in the required curve. It must be remembered that the deflection angles are always twice the tangential angles. In the table the tangential angles are given in the first column, the deflection angles in the second and the radii of curves for chords of 1 in the third column.*

TABLE OF RADII—CHORD, ONE FOOT.

| Tangential Angle. | Angle of Deflection. | Radius in Feet. | Tangential Angle. | Angle of Deflection. | Radius in Feet. | Tangential Angle. | Angle of Deflection. | Radius in Feet. |
|---|---|---|---|---|---|---|---|---|
| | | Ft. | | | Ft. | | | Ft. |
| 0° 0½′ | 0° 1′ | 3437·61 | 0° 22′ | 0° 44′ | 78·13 | 0° 57′ | 1° 54′ | 30·157 |
| 1′ | 2′ | 1718·80 | 22½′ | 45′ | 76·39 | 58′ | 1° 56′ | 29·637 |
| 1½′ | 3′ | 1145·87 | 23′ | 46′ | 74·73 | 59′ | 1° 58′ | 29·135 |
| 2′ | 4′ | 859·40 | 23½′ | 47′ | 73·14 | 1° 0′ | 2° 0′ | 28·649 |
| 2½′ | 5′ | 687·52 | 24′ | 48′ | 71·62 | 1° 1′ | 2° 2′ | 28·180 |
| 3′ | 6′ | 572·93 | 24½′ | 49′ | 70·16 | 1° 2′ | 2° 4′ | 27·725 |
| 3½′ | 7′ | 491·09 | 25′ | 50′ | 68·76 | 1° 3′ | 2° 6′ | 27·285 |
| 4′ | 8′ | 429·70 | 25½′ | 51′ | 67·41 | 1° 4′ | 2° 8′ | 26·859 |
| 4½′ | 9′ | 381·97 | 26′ | 52′ | 66·11 | 1° 5′ | 2° 10′ | 26·446 |
| 5′ | 10′ | 343·78 | 26½′ | 53′ | 64·86 | 1° 6′ | 2° 12′ | 26·045 |
| 5½′ | 11′ | 312·52 | 27′ | 54′ | 63·66 | 1° 7′ | 2° 14′ | 25·656 |
| 6′ | 12′ | 286·48 | 27½′ | 55′ | 62·51 | 1° 8′ | 2° 16′ | 25·279 |
| 6½′ | 13′ | 264·44 | 28′ | 56′ | 61·39 | 1° 9′ | 2° 18′ | 24·913 |
| 7′ | 14′ | 245·55 | 28½′ | 57′ | 60·31 | 1° 10′ | 2° 20′ | 24·557 |
| 7½′ | 15′ | 229·18 | 29′ | 58′ | 59·27 | 1° 11′ | 2° 22′ | 24·211 |
| 8′ | 16′ | 214·86 | 29½′ | 59′ | 58·27 | 1° 12′ | 2° 24′ | 23·875 |
| 8½′ | 17′ | 202·22 | 30′ | 1° 0′ | 57·30 | 1° 13′ | 2° 26′ | 23·548 |
| 9′ | 18′ | 190·98 | 31′ | 1° 2′ | 55·45 | 1° 14′ | 2° 28′ | 23·230 |
| 9½′ | 19′ | 180·94 | 32′ | 1° 4′ | 53·72 | 1° 15′ | 2° 30′ | 22·920 |
| 10′ | 20′ | 171·89 | 33′ | 1° 6′ | 52·09 | 1° 16′ | 2° 32′ | 22·619 |
| 10½′ | 21′ | 163·70 | 34′ | 1° 8′ | 50·56 | 1° 17′ | 2° 34′ | 22·325 |
| 11′ | 22′ | 156·26 | 35′ | 1° 10′ | 49·11 | 1° 18′ | 2° 36′ | 22·039 |
| 11½′ | 23′ | 149·47 | 36′ | 1° 12′ | 47·75 | 1° 19′ | 2° 38′ | 21·760 |
| 12′ | 24′ | 143·24 | 37′ | 1° 14′ | 46·46 | 1° 20′ | 2° 40′ | 21·488 |
| 12½′ | 25′ | 137·51 | 38′ | 1° 16′ | 45·23 | 1° 21′ | 2° 42′ | 21·223 |
| 13′ | 26′ | 132·22 | 39′ | 1° 18′ | 44·07 | 1° 22′ | 2° 44′ | 20·964 |
| 13½′ | 27′ | 127·32 | 40′ | 1° 20′ | 42·97 | 1° 23′ | 2° 46′ | 20·711 |
| 14′ | 28′ | 122·78 | 41′ | 1° 22′ | 41·92 | 1° 24′ | 2° 48′ | 20·465 |
| 14½′ | 29′ | 118·54 | 42′ | 1° 24′ | 40·93 | 1° 25′ | 2° 50′ | 20·224 |
| 15′ | 30′ | 114·59 | 43′ | 1° 26′ | 39·97 | 1° 26′ | 2° 52′ | 19·989 |
| 15½′ | 31′ | 110·90 | 44′ | 1° 28′ | 39·07 | 1° 27′ | 2° 54′ | 19·759 |
| 16′ | 32′ | 107·43 | 45′ | 1° 30′ | 38·20 | 1° 28′ | 2° 56′ | 19·535 |
| 16½′ | 33′ | 104·17 | 46′ | 1° 32′ | 37·37 | 1° 29′ | 2° 58′ | 19·315 |
| 17′ | 34′ | 101·11 | 47′ | 1° 34′ | 36·57 | 1° 30′ | 3° 0′ | 19·101 |
| 17½′ | 35′ | 98·22 | 48′ | 1° 36′ | 35·81 | 1° 31′ | 3° 2′ | 18·891 |
| 18′ | 36′ | 95·49 | 49′ | 1° 38′ | 35·08 | 1° 32′ | 3° 4′ | 18·686 |
| 18½′ | 37′ | 92·91 | 50′ | 1° 40′ | 34·38 | 1° 33′ | 3° 6′ | 18·485 |
| 19′ | 38′ | 90·47 | 51′ | 1° 42′ | 33·70 | 1° 34′ | 3° 8′ | 18·288 |
| 19½′ | 39′ | 88·15 | 52′ | 1° 44′ | 33·06 | 1° 35′ | 3° 10′ | 18·096 |
| 20′ | 40′ | 85·94 | 53′ | 1° 46′ | 32·43 | 1° 36′ | 3° 12′ | 17·907 |
| 20½′ | 41′ | 83·85 | 54′ | 1° 48′ | 31·83 | 1° 37′ | 3° 14′ | 17·723 |
| 21′ | 42′ | 81·85 | 55′ | 1° 50′ | 31·25 | 1° 38′ | 3° 16′ | 17·542 |
| 21½′ | 43′ | 79·95 | 56′ | 1° 52′ | 30·70 | 1° 39′ | 3° 18′ | 17·365 |

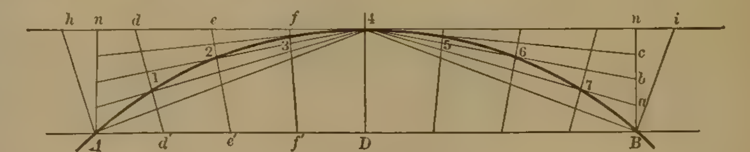



Fig. 243.

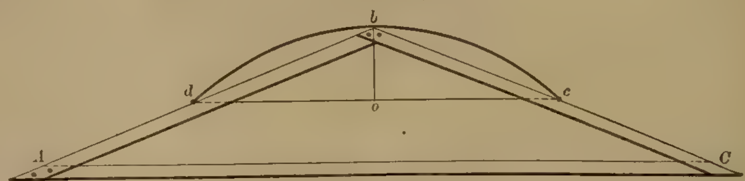



Fig. 244.

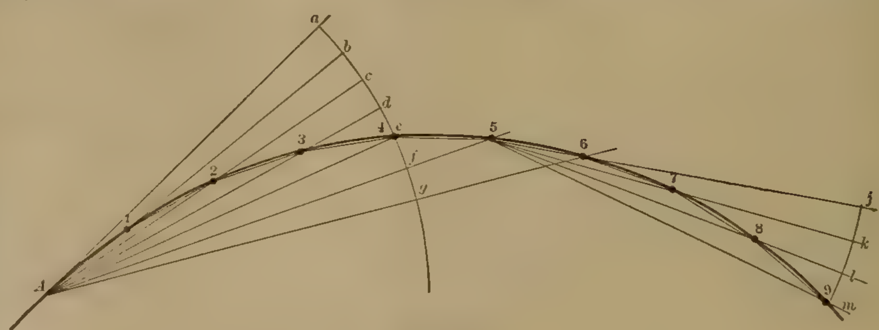



Fig. 245.

THE ELLIPSE.

An ellipse is an oval-shaped curve, fig. 247, which has the characteristic property that the sum of the distances of any point in the curve from two points, *a* and *b*, called the *foci*, is

* Students who wish to study this subject still further are advised to read "The Field Practice of Laying out Circular Curves for Railroads," by John C. Trautwine, C.E.

TABLE OF RADII—CHORD, ONE FOOT. (*Continued.*)

| Tangential Angle. | Angle of Deflection. | Radius in Feet. | Tangential Angle. | Angle of Deflection. | Radius in Feet. | Tangential Angle. | Angle of Deflection. | Radius in Feet. |
|---|---|---|---|---|---|---|---|---|
| | | Ft. | | | Ft. | | | Ft. |
| 1° 40′ | 3° 20′ | 17·191 | 2° 57½′ | 5° 55′ | 9·688 | 6° 15′ | 12° 30′ | 4·593 |
| 1° 41′ | 3° 22′ | 17·021 | 3° 0′ | 6° 0′ | 9·554 | 6° 22½′ | 12° 45′ | 4·503 |
| 1° 42′ | 3° 24′ | 16·854 | 3° 2½′ | 6° 5′ | 9·423 | 6° 30′ | 13° 0′ | 4·417 |
| 1° 43′ | 3° 26′ | 16·691 | 3° 5′ | 6° 10′ | 9·296 | 6° 37½′ | 13° 15′ | 4·334 |
| 1° 44′ | 3° 28′ | 16·530 | 3° 7½′ | 6° 15′ | 9·172 | 6° 45′ | 13° 30′ | 4·254 |
| 1° 45′ | 3° 30′ | 16·373 | 3° 10′ | 6° 20′ | 9·051 | 6° 52½′ | 13° 45′ | 4·177 |
| 1° 46′ | 3° 32′ | 16·218 | 3° 12½′ | 6° 25′ | 8·934 | 7° 0′ | 14° 0′ | 4·103 |
| 1° 47′ | 3° 34′ | 16·067 | 3° 15′ | 6° 30′ | 8·819 | 7° 7½′ | 14° 15′ | 4·031 |
| 1° 48′ | 3° 36′ | 15·918 | 3° 17½′ | 6° 35′ | 8·708 | 7° 15′ | 14° 30′ | 3·962 |
| 1° 49′ | 3° 38′ | 15·772 | 3° 20′ | 6° 40′ | 8·599 | 7° 22½′ | 14° 45′ | 3·895 |
| 1° 50′ | 3° 40′ | 15·629 | 3° 22½′ | 6° 45′ | 8·493 | 7° 30′ | 15° 0′ | 3.831 |
| 1° 51′ | 3° 42′ | 15·488 | 3° 25′ | 6° 50′ | 8·390 | 7° 37½′ | 15° 15′ | 3·768 |
| 1° 52′ | 3° 44′ | 15·350 | 3° 27½′ | 6° 55′ | 8·289 | 7° 45′ | 15° 30′ | 3.708 |
| 1° 53′ | 3° 46′ | 15 214 | 3° 30′ | 7° 0′ | 8·190 | 7° 52½′ | 15° 45′ | 3·649 |
| 1° 54′ | 3° 48′ | 15·081 | 3° 32½′ | 7° 5′ | 8·094 | 8° 0′ | 16° 0′ | 3·593 |
| 1° 55′ | 3° 50′ | 14·950 | 3° 35′ | 7° 10′ | 8·000 | 8° 15′ | 16° 30′ | 3·485 |
| 1° 56′ | 3° 52′ | 14·821 | 3° 37½′ | 7° 15′ | 7·908 | 8° 30′ | 17° 0′ | 3·383 |
| 1° 57′ | 3° 54′ | 14·694 | 3° 40′ | 7° 20′ | 7·818 | 8° 45′ | 17° 30′ | 3·287 |
| 1° 58′ | 3° 56′ | 14·570 | 3° 42½′ | 7° 25′ | 7·731 | 9° 0′ | 18° 0′ | 3·196 |
| 1° 59′ | 3° 58′ | 14·447 | 3° 45′ | 7° 30′ | 7·645 | 9° 15′ | 18° 30′ | 3·111 |
| 2° 0′ | 4° 0′ | 14·327 | 3° 47½′ | 7° 35′ | 7·561 | 9° 30′ | 19° 0′ | 3·029 |
| 2° 2½′ | 4° 5′ | 14·034 | 3° 50′ | 7° 40′ | 7·479 | 9° 45′ | 19° 30′ | 2·953 |
| 2° 5′ | 4° 10′ | 13·754 | 3° 52½′ | 7° 45′ | 7·399 | 10° 0′ | 20° 0′ | 2·879 |
| 2° 7½′ | 4° 15′ | 13·484 | 3° 55′ | 7° 50′ | 7·320 | 10° 30′ | 21° 0′ | 2·744 |
| 2° 10′ | 4° 20′ | 13·225 | 3° 57½′ | 7° 55′ | 7·243 | 11° 0′ | 22° 0′ | 2·620 |
| 2° 12½′ | 4° 25′ | 12·976 | 4° 0′ | 8° 0′ | 7·168 | 11° 30′ | 23° 0′ | 2·508 |
| 2° 15′ | 4° 30′ | 12·736 | 4° 7½′ | 8° 15′ | 6·951 | 12° 0′ | 24° 0′ | 2·405 |
| 2° 17½′ | 4° 35′ | 12·504 | 4° 15′ | 8° 30′ | 6·747 | 12° 30′ | 25° 0′ | 2·310 |
| 2° 20′ | 4° 40′ | 12·281 | 4° 22½′ | 8° 45′ | 6·554 | 13° 0′ | 26° 0′ | 2·223 |
| 2° 22½′ | 4° 45′ | 12·066 | 4° 30′ | 9° 0′ | 6·373 | 13° 30′ | 27° 0′ | 1·142 |
| 2° 25′ | 4° 50′ | 11·858 | 4° 37½′ | 9° 15′ | 6·201 | 14° 0′ | 28° 0′ | 2·067 |
| 2° 27½′ | 4° 55′ | 11·657 | 4° 45′ | 9° 30′ | 6·038 | 14° 30′ | 29° 0′ | 1·997 |
| 2° 30′ | 5° 0′ | 11·463 | 4° 52½′ | 9° 45′ | 5·884 | 15° 0′ | 30° 0′ | 1·932 |
| 2° 32½′ | 5° 5′ | 11·275 | 5° 0′ | 10° 0′ | 5·737 | 15° 30′ | 31° 0′ | 1·871 |
| 2° 35′ | 5° 10′ | 11·093 | 5° 7½′ | 10° 15′ | 5·597 | 16° 0′ | 32° 0′ | 1·814 |
| 2° 37½′ | 5° 15′ | 10·917 | 5° 15′ | 10° 30′ | 5·464 | 16° 30′ | 33° 0′ | 1·760 |
| 2° 40′ | 5° 20′ | 10·747 | 5° 22½′ | 10° 45′ | 5·338 | 17° 0′ | 34° 0′ | 1·710 |
| 2° 42½′ | 5° 25′ | 10·582 | 5° 30′ | 11° 0′ | 5·217 | 17° 30′ | 35° 0′ | 1·663 |
| 2° 45′ | 5° 30′ | 10·421 | 5° 37½′ | 11° 15′ | 5·101 | 18° 0′ | 36° 0′ | 1·618 |
| 2° 47½′ | 5° 35′ | 10·266 | 5° 45′ | 11° 30′ | 4·991 | 18° 30′ | 37° 0′ | 1.576 |
| 2° 50′ | 5° 40′ | 10·115 | 5° 52½′ | 11° 45′ | 4·885 | 19° 0′ | 38° 0′ | 1·536 |
| 2° 52½′ | 5° 45′ | 9·969 | 6° 0′ | 12° 0′ | 4·783 | 19° 30′ | 39° 0′ | 1·498 |
| 2° 55′ | 5° 50′ | 9·826 | 6° 7½′ | 12° 15′ | 4·686 | 20° 0′ | 40° 0′ | 1·462 |

equal to the long diameter, $C D$, called the *major* or *conjugate axis.* Thus, in fig. 247, the distance $a c + c b = C D$, and $a e + e b = C D$. If we measure the distance of any point of the curve from the two foci, and add these distances together, their sum will be equal to the major axis.

Ellipses also have the peculiarity that the nearer their two axes are of the same length, the more the curve approximates to a circle, and it will coincide with a circle if the axes are of equal length; on the other hand, if the minor axis is shortened in proportion to the major axis, the length of the figure will approximate to a straight line, and will become such a line if the short diameter is infinitely small. Ellipses may, therefore, be round or flat, but they always have the properties described above.

PROBLEM 69. *To draw an ellipse with a string and pencil.*

Lay down the major axis $C D$, fig. 247, and bisect it at $E$, and draw the minor axis $c d$ through $E$ and perpendicular to $C D$. To find the foci, take half the length of $C D$, and from $c$ or $d$ as a center, draw arcs intersecting $C D$ at $a$ and $b$. The points of intersection will be the foci. Take a string whose length is just equal to $C D$, and drive nails or pins in the foci and in $c$ or $d$. Pass the string around the three pins and tie it to $a$ and $b$. Take out the pin at $c$ and substitute a pencil, and draw the string tight. The pencil may then be moved along inside of the loop so as to trace an ellipse on the paper. It is difficult to draw accurately or neatly by this method, especially if the ellipses are small.

PROBLEM 70. *To lay off an ellipse with a straight edge.*

Draw the major and minor axes $A B$ and $C D$, fig. 248. Then on a thin wooden straight edge, slip of stiff paper, or card $s s$, mark lines $e$ and $g$, whose distance apart, $e g$, is equal to $O B$, or half the major axis, and make $g f$ equal to $O C$, or half the minor axis. Move the straight edge so that the points $e$ and $f$ will coincide with the $A B$ and $C D$, and then mark the point $g$, which will be in the curve of the ellipse. Move the straight edge into other positions, being careful that $e$ and $f$ always coincide with $A B$ and $C D$, and from $g$ mark as many points in the curve as may be desirable. It can then be drawn through these points, as has been explained.

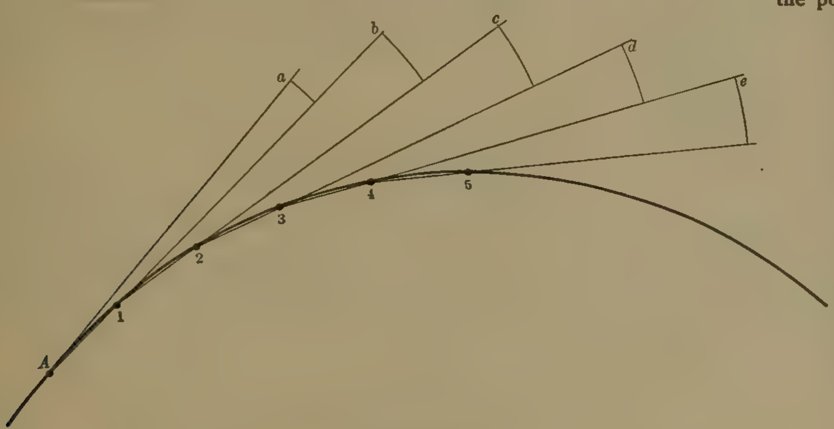


Fig. 246.

PROBLEM 71. *To lay out the curve of an ellipse, the two axes being given.*

Draw the two axes $A B$ and $C D$, fig. 249, at right angles to each other. From their point of intersection, $E$ as a center and one-half the short axis, describe a circle, $C c$, $F D$; and also from $E$, with half the major axis as a radius, draw another circle, $A H B I$. Divide the larger circle into any number of equal parts—sixteen in this instance. From the center $E$ draw radii through the points of subdivision and cutting the inside circle. From the points of intersection of these radii with the large circle, draw perpendiculars 1 1″, 2 2″, 3 3″, etc., and from the points of intersection, 1′, 2′, 3′, etc., with the small circle draw horizontal lines, 1′ 1″, 2′ 2″, 3′ 3″,

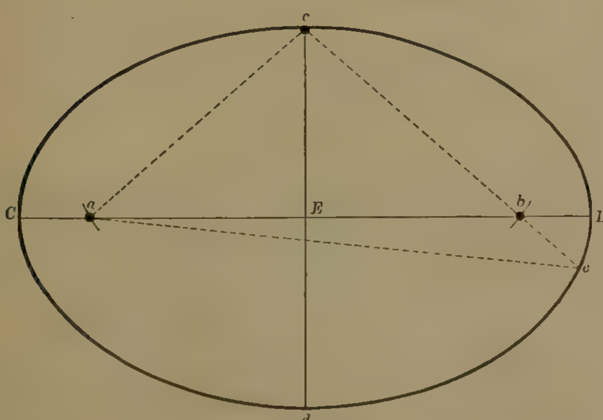


Fig. 247.

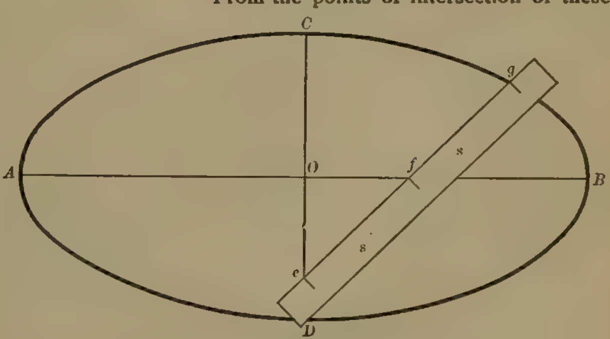


Fig. 248.

etc.; then the points of intersection, $1''$, $2''$, $3''$, etc., of these lines will be points in the ellipse, which can be drawn by a templet in the same way as has been described for drawing arcs of circles.

The curve of the ellipse may be drawn through the points thus laid down with a very close approximation to correctness by finding centers *a* and *b* by trial on the major axis, from which arcs of circles may be drawn which will coincide very closely to the ends of the ellipse from $3''$ to $5''$ and $11''$ to $13''$. In the same way centers may be found at *c* and *d* on the minor axis, extended from which portions of the top and bottom of the

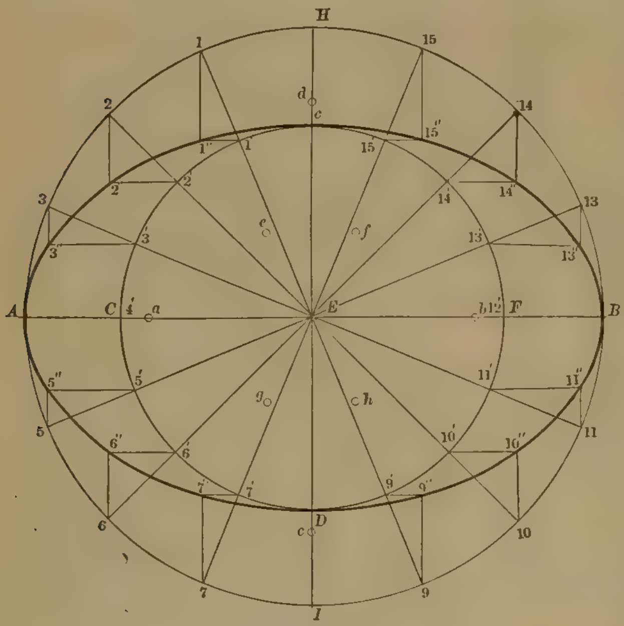


Fig. 249.

ellipse can be drawn. Other centers, *e f g h*, may then be found by trial from which arcs may be drawn, which will unite those which represent the ends and the top and bottom of the ellipse, and which will pass through the points in the ellipse which have been laid down. It is impossible to draw ellipses correctly with compasses, and at best when drawn with such instruments, the curves are only approximately correct, and are decidedly inferior to true ellipses in point of regularity and beauty of contour.

PROBLEM 72. *To lay out an ellipse.*

The fact that the sum of the distances of any point in an ellipse is equal to its major axis gives an easy method of laying off any number of points in the ellipse. Let *A B*, fig. 250, be the major and *C D* the minor axis in an ellipse. To lay off the two foci, take *A E* = one-half of *A B* as a radius, and from *C* or *D* as a center draw arcs at *e* and *f* intersecting *A B*; then these points of intersection will be the foci. Then lay off any

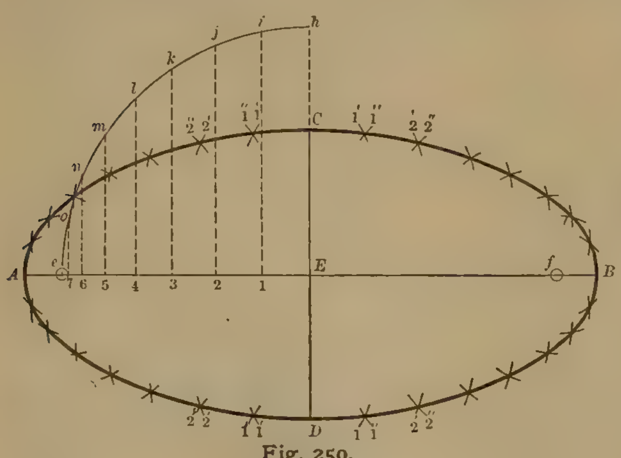


Fig. 250.

number of points, 1, 2, 3, 4, 5, 6, 7, between the center *E* and the focus *e*, and with *B* 1 as a radius and *e* and *f* as centers describe arcs $1'$, $1'$, $1'$, $1'$; and with 1 *A* as a radius and from the same centers describe arcs $1''$, $1''$, $1''$, $1''$, intersecting $1'$—$1'$. The points of intersection will be points in the ellipse. Then with *B* 2 and *A* 2 as radii proceed in the same manner, which will give other points in the ellipse, and by taking successively *B* 3, *A* 3, *B* 4, *A* 4, etc., as radii still other points may be laid down. The curve of the ellipse can then be drawn either with a template or compasses, as has been described.

It will be found desirable that the points laid off between *e* and *E* should be nearer together next to *e* than they are next to *E*. For this reason it is well to draw a quarter circle *e h* from the center *E* with a radius *E e*. The arc *e h* should then be divided into any number of equal parts. From the points of subdivision *i j k*, etc., draw perpendicular lines *i* 1, *j* 2, *k* 3, etc., to *A g*. The points 1, 2, 3, etc., will thus be nearer together as they approach *e*.

PROBLEM 73. *Another method of laying out an ellipse.*

Having drawn the major and minor axes *A B* and *C D*, fig. 251, construct a rectangle *f g h i*, whose sides are parallel to the axes and pass through their extremities, *A*, *C*, *B*, *D*. Divide *A E* and *A F* into the same number of equal parts, 1, 2, 3, 4, 5, and $1'$, $2'$, $3'$, $4'$, $5'$. Draw lines from *D* through 1, 2, 3, etc., to meet lines from *C* through $1'$, $2'$, $3'$, etc., on *A F*. Their points of intersection, $1''$, $2''$, $3''$, etc., are points in the ellipse. The other portions of it can be laid out in a similar way. This method can be advantageously employed for laying off a semi-elliptical arch.

PROBLEM 74. *To lay off an ellipse by ordinates.**

Draw *A B*, fig. 252, the major axis of the ellipse, and $8''$ 8, one-half the minor axis, perpendicular to *A B* at its middle point, 8.

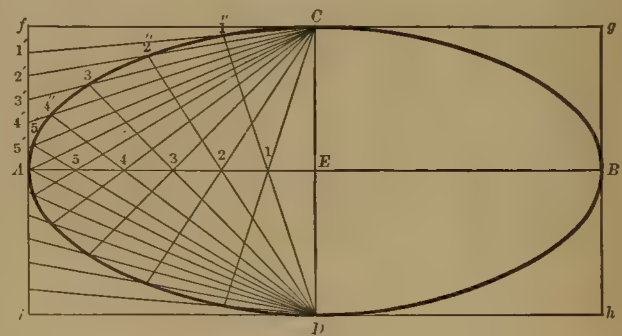


Fig. 251.

Subdivide each half of the major axis into eight equal parts, and draw perpendicular lines or ordinates 1 $1'$, 2 $2'$, 3 $3'$, etc., to *A B* through the points of subdivision. Then multiply one-half the length of the minor axis, or 8 $8''$, by the numbers on the ordinates in fig. 252; the products will be the lengths of the corresponding ordinates, which can be laid off with dividers from *A B*. Similar ordinates can be laid off on the right side of the minor axis $8''$ 8 and below the major axis *A B* to complete the ellipse. In practice it saves time to lay off *A* $8''$ 8, or one-quarter of the ellipse, and make a template for it, the lower edge of

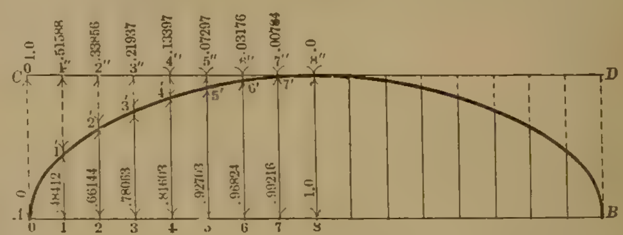



Fig. 252.

which is made straight, to coincide with *A* 8, and the left-hand edge to coincide with the minor axis $8''$ 8. By reversing this template the whole of the ellipse can be drawn.

The numbers above the line *C D* are the "*complements*" of the ordinates or the distances $1''$ $1'$, $2''$ $2'$, $3''$ $3'$, etc., from the line *C D* to the curve. A semi-ellipse may, therefore, be laid off by drawing ordinates below *C D* and multiplying one-half the minor axis, or $8''$ 8, by the complements, and laying off the lengths of the ordinates below *C D*.†

* An "*ordinate*" is a line drawn perpendicular to either axis of the ellipse and terminating in the curve. Thus in Fig. 1 $1'$, 2 $2'$, 3 $3'$, etc., are ordinates.
† From Molesworth's "Pocket-Book of Engineering Formulæ."

PROBLEM 75. *An ellipse being given to find the axes and foci.** If $A\ C\ B\ D$, fig. 253, is the ellipse, draw any two chords, as $E\ F$ and $G\ H$, parallel to each other. Bisect each of these in $I$ and $J$, and draw $I\ J$ through the points of division and to intersect the ellipse at $K$ and $L$. This line divides the ellipse obliquely into two equal parts. Bisect $L\ K$ at $O$, with any radius, draw a circle cutting the ellipse in $M\ N\ P\ Q$. Join these four points

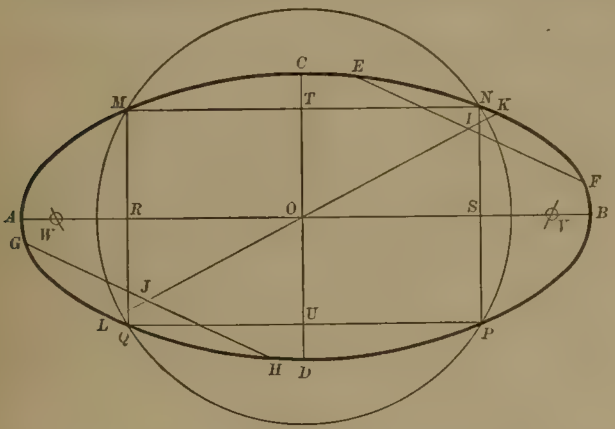



Fig. 253.

by lines, which will form a rectangle within the ellipse. Bisect the sides of this rectangle in $R$, $S$, $T$ and $U$, and draw lines $A\ B$ and $C\ D$ through the points of division. These lines will be the axes of the ellipse.

The foci may be found by describing arcs from $C$ or $D$ as centers, with $O\ B$ as a radius, so as to intersect $A\ B$ at $W$ and $V$. The points of intersection will then be the foci.

PROBLEM 76. *To draw a line perpendicular to the curve of an ellipse at a given point A, fig.* 254.

Find the axes and foci, as in the last figure. From the foci $W$ and $V$ draw lines through $A$, and extend them outside of the ellipse. Bisect the angle $B\ A\ C$, and draw a bisecting line $A\ D$, which will be perpendicular to the curve of the ellipse at $A$. The stones of which an elliptical arch are formed may be laid out by repeating this process.

PROBLEM 77. *To draw a tangent to the curve of an ellipse at a given point E, fig.* 254.

Draw lines $V\ E$ and $W\ E$ from the foci through the point

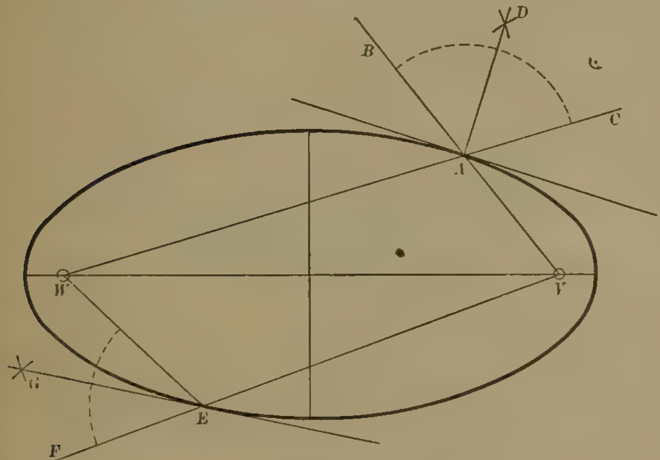



Fig. 254.

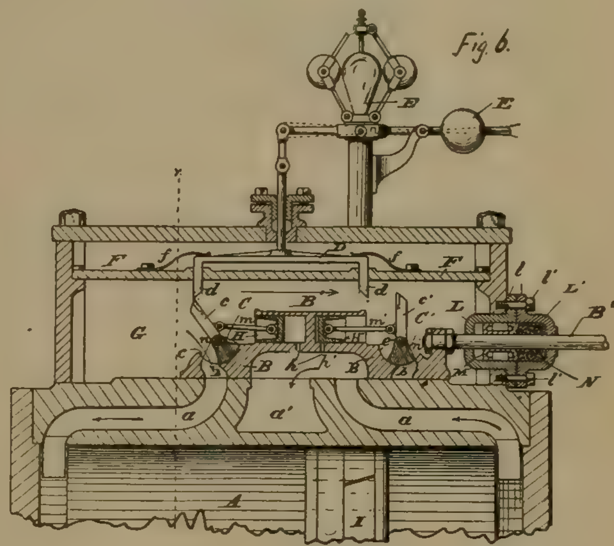
$E$, and extend $V\ E$ outside of the ellipse. Bisect the angle $W\ E\ F$ by the line $G\ E$, which will be tangent to the ellipse at $E$.

(TO BE CONTINUED.)

## Recent Patents.

KING'S CUT-OFF VALVE.

FIG. 6 represents an ingenious arrangement of cut-off valves intended to be used in connection with a $D$ slide-valve. The ends or "laps" of the slide-valve are made to extend over the steam-ports $a\ a$, and admission-ports $b\ b'$ are provided in the laps. These admission-ports are covered with segmental cut-off valves $C\ C'$, which work in correspondingly shaped seats on top of the slide-valve. The cut-off valves work on journals at $n\ n'$ attached to lugs at each end of the segmental seats, and the valves oscillate on these journals. The cut-off valves also have arms $c$ and $c'$ attached to them which are connected by rods $m\ m'$ to pistons $H\ H'$, which work in a double cylinder $B'$ cast on top of the slide-valve. The cylinders have holes $h$ and




KING'S CUT-OFF VALVE.

$h'$ in their inner ends, which communicate with the exhaust cavity $B\ B$ of the slide-valve, so that any steam behind the pistons can escape. The upper ends of the arms $c\ c'$ have tripping latches which engage with detents $d\ d'$. The vertical position of these is regulated by the governor $E$ in a manner which will be readily understood from the engraving.

The operation of the valves is as follows: If the slide-valve $B\ B$ is moving toward the right side, as indicated by the dart $B'$, the tripping-arm $c$ engages with the detent $d$, and the movement of the slide-valve thus causes the cut-off valve $C$ to oscillate on its seat and open the admission-port $b$, and at the same time the rod $m$ draws the piston $H$ outward in its cylinder against the steam pressure in the steam chest. When the slide-valve has moved so far that the tripping-latch is disengaged from the detent $d$ the steam pressure on the piston $H$ forces it into its cylinder, and thus moves the cut-off valve $C$ and quickly closes the admission-port $b$ and cuts off the steam. The action of the valve $C'$, which is represented in the position it occupies when the port $b'$ is closed, is exactly similar to that of $C$.

Mr. John H. King, of Cincinnati, is the inventor. His patent is numbered 449,123.

MULTIPLE EXPANSION ENGINE.

Figs. 7, 8, 9 and 10 represent improvements in Multiple Expansion Engines for Screw Propulsion, patented by Mr. Hugh Dunsmuir, of Govan, Scotland. He describes his invention as follows:

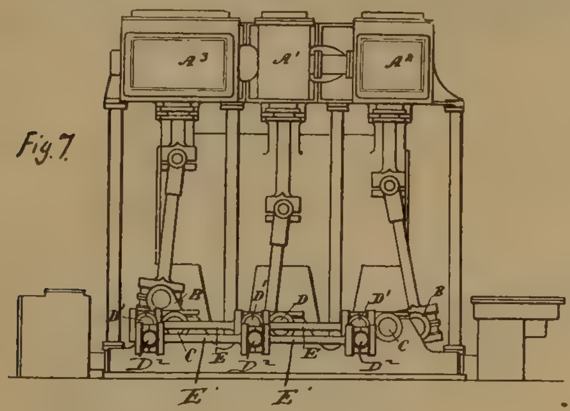
In adapting triple expansion-engines to operate the propeller-shaft in a single screw-steamer, as represented at figs. 7 and 8, the intermediate and low-pressure cylinders $A^2$ and $A^3$ are directly connected each to a crank $B$ on a short shaft $C$, while the high-pressure cylinder $A'$ is connected to a crank on the propeller-shaft $D$; or the arrangement may be varied. The two side crank-shafts $C$ and the propeller-shaft $D$ are connected together either by cranks or disks and differently situated crank-pins $D'\ D^2$ and connecting-rods $E\ E'$, which are provided in pairs, as shown, to insure rotation of the several shafts in the same direction.

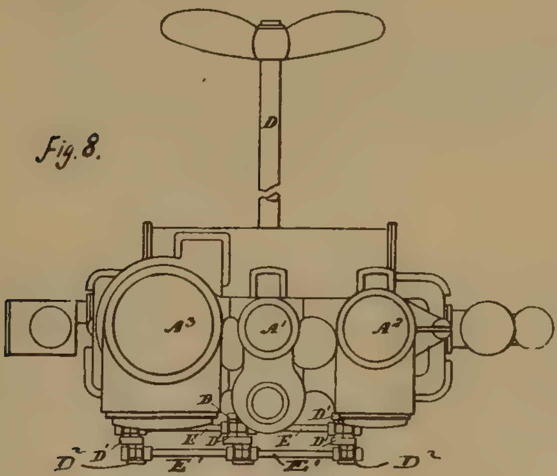
In adapting triple expansion-engines to operate the propeller-shafts in a twin-screw steamer, as represented at figs. 9 and 10, the high-pressure and low-pressure cylinders $A'$ and $A^3$ are directly connected each to one of the crank or propeller shafts $D$, while the intermediate cylinder is connected to a separate crank-shaft $C$, or the arrangement may be varied; and in order that the power and speed of rotation of the two propeller-shafts

* This and the following problem are taken from "Linear Drawing," by Ellis A. Davidson.

may be equalized and economical working insured, the three crank-shafts are connected together, as shown, by cranks or disks and connecting-rods.

In his specifications he also shows similar plans of applying triple expansion-engines to driving three propeller-shafts, quadruple expansion tandem-engines arranged to drive two propeller-shafts, quadruple expansion-engines for driving four




DUNSMUIR'S MARINE ENGINE.

propeller-shafts, and two-cylinder compound engines geared to drive twin screw-shafts.

## Sound Aluminum Castings.

SOUND castings of aluminum can be obtained in dry sand moulds, preferably lined with plumbago. The metal should be heated to a temperature very little above its melting point, and should be poured quickly. The shrinkage of the above metal is $\frac{17}{64}$ inch to the foot (2.26 per cent. of the length of the mould.)

The above statement, which has been widely published, is not only true as to aluminum, but to all metal castings. Actual sales of plumbago show that barrels of plumbago are now used in shops where pounds were formerly called for. Its use absolutely guarantees to the casting a smooth surface and bright color. Caution is suggested, when purchasing, to obtain exactly the kind wanted for the different work. It can be said of plumbago as the Irishman said of whiskey: "None is bad, but some is better than others." One kind of plumbago is better applied by the shake-bag; and, if the brush is used, another kind will prove better. One preparation of plumbago will "sleek," another will not. Another kind is more useful for light castings, another kind for heavier work.

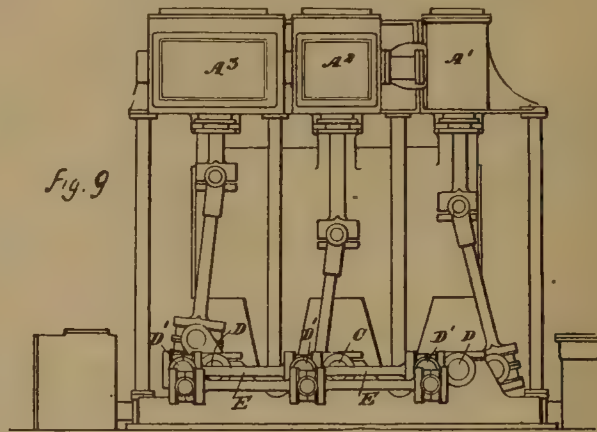
Good plumbago will stand the heat, and will neither burn nor run before the molten metal.

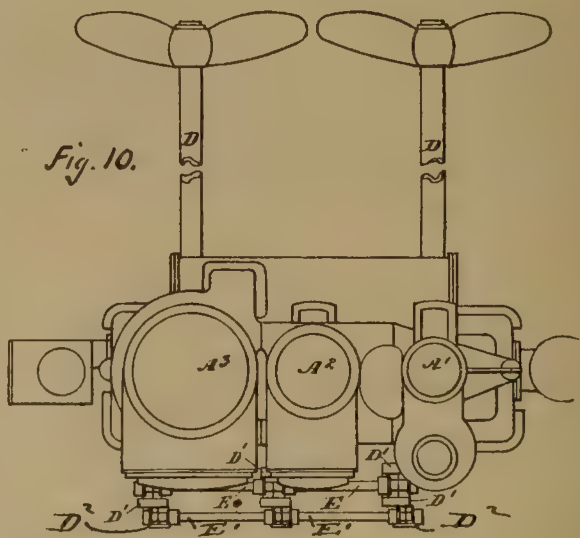
A wash of plumbago for cores, loam work and dry sand castings is indispensable.

The Dixon Crucible Company, of Jersey City, N. J., have made a patient study of the subject, and being the only miners of plumbago who afterward prepare it for its many uses, they can give advice on the subject not elsewhere obtainable. This is contained in a little book, which can be had from them on application.

## Civil Service Examination for Draftsmen.

AN examination will be held by the Civil Service Commission at Washington, D. C., commencing at 9 A.M., May 12, to fill




DUNSMUIR'S MARINE ENGINE.

vacancies in the Supervising Architect's office, Treasury Department, as follows:

1. *Junior draftsmen*, who must have two years' practice or study in the principles of architecture; salary \$3 a day (Sundays excepted).

2. *Senior draftsmen*, who must be experienced as assistant architects; salary \$5 to \$8 a day, rate of salary to be determined after trial in office.

3. *Draftsmen* who have practical knowledge of steam and hot-water heating apparatus; salary \$5 a day (Sundays excepted).

4. *Engineer draftsmen*, skilled in iron-work and building construction; salary \$6 to \$8 a day, rate of salary to be determined after trial in office.

If there are many applicants from the vicinity of large cities, such as Boston, New York, Pittsburgh or Chicago, arrangements may perhaps be made to hold examinations in such cities if requests are received in time. Blank forms of application may be obtained of the Commission.

# Manufactures.

## Baltimore Notes.

THE trustees of the Chesapeake & Ohio Canal are making their final arrangements for having the canal in operation by May 1, as required by the order of Court. The trustees are Mr. John K. Cowen, General Counsel of the Baltimore & Ohio; Colonel Bradley S. Johnson and Hugh L. Bond, of Baltimore; H. H. Keedy, of Hagerstown, Md., and Joseph Bryan, of Richmond.

WITHIN the past ten days, ex-Senator H. G. Davis, President of the West Virginia Central & Pittsburgh Railroad, has had several interviews with Mayor Davidson, and it is generally believed among railroad men here that the Western Maryland Railroad will soon be sold to a syndicate, who will operate it in connection with the West Virginia Central. It is said that the recent purchase of the Camden System of roads in West Virginia by the Baltimore & Ohio, and the failure of the Central to secure the bed of the Chesapeake & Ohio Canal, has made it necessary for the latter road to seek an outlet through the Western Maryland; and this is very much strengthened bv the fact that the Central is locating a line from Cumberland to Williamsport, the terminus of the Western Maryland.

A WELL-AUTHENTICATED statement has it that the Baltimore & Ohio Company is seriously considering the plans for the extension of the Valley Railroad from Lexington to Roanoke, Va. The distance is about 54 miles, and it is said that the surveys and estimates have been made. If carried out, this will without question be the Baltimore & Ohio route to the South. The Roanoke Southern, which will be built southward from Winston to Monroe, N. C., will be the most valuable connection.

THE South Baltimore Car Works, Curtis Bay, have just closed a contract with the Baltimore & Ohio for the construction of 250 hopper gondola cars of 60,000 lbs. capacity.

IT is said that the Baltimore & Ohio will shortly be in the market for 50 cars of passenger equipment made up of coaches and combined cars.

SOME weeks ago the Ries Electric Traction & Brake Company, of Baltimore, applied their traction-increasing system to Baltimore & Ohio engine 806 for trial. The test was made with an alternating current dynamo, with exciter on same shaft; but the results not being entirely satisfactory, the engine has been ordered into shop, and the alternating current dynamo will be removed and replaced with a direct current dynamo of much greater capacity—perhaps 8,000 ampères—when a further trial will be made. The alternating current dynamo had a capacity of about 4,000 ampères.

THE Scranton Steel Company, of Pennsylvania, by their counsel, have filed a bill in the Circuit Court against the Baltimore & Eastern Shore Railroad Company, of Baltimore, and the Atlantic Trust Company, of New York, trustee, asking for a receiver. This action is brought about by the non-payment of a promissory note for steel rail furnished.

WORK on the Baltimore Belt Railroad tunnel is now progressing rapidly. The tunnel is being driven from six different points; four shafts are located on Howard Street, respectively near German, Lexington, Franklin and Madison streets; one shaft at Park and Preston streets, and through the old Bolton depot property the tunnel is being built by opening the surface of the ground. The open cuts from Hamburg to Camden streets and along Seventh Street in the northern part of the city are being pushed rapidly.

## Steel Rails for Australia.

THE Government of New South Wales has made a proposition to steel rail manufacturers, and has invited bids for the supply of 175,000 tons of rails, to be made from material entirely manufactured in the colony from native iron ore and coal or coke. Delivery is to begin in January, 1893, and is to be for three years at the rate of 25,000 tons a year, and for two years at the rate of 50,000 a year. The price is to be regulated by the ruling prices for similar rails in England, with freight and other charges to Sydney added. The bids will be received by the Minister of Public Works in Sydney, and the Agent-General of the Colony in London up to June 24 next.

The attempt of the Colony of New South Wales to establish locomotive works was not successful, and it remains to be seen whether the rail manufacturers will be more ready to take up the offer than the locomotive builders were.

## General Notes.

THE Worthington Pump Company has begun work on a branch factory at Elizabeth, N. J. The establishment there will consist of a foundry 143 × 343 ft., with an L 93 × 200 ft., and a pattern and storage shop 80 × 180 ft., and will be a branch of the present works in Brooklyn.

THE Lane Bridge & Iron Company, of Chicago, is building a highway bridge over the Trinity River at Ft. Worth, Tex.

THE Grand Trunk Company is building a rolling mill and steam forge as an addition to its shops at Point St. Charles, near Montreal.

THE Consolidated Car Heating Company, of Albany, N. Y., removed its Chicago office on May 1 to Room 200, Phenix Building. These rooms will always be open to railroad men, and will be supplied with models of its car heating and other apparatus. This Company submitted an elaborate brief to the meeting recently held of the Superintendents of Motive Power of the Vanderbilt Lines, showing the requirements for a uniform coupler for steam heating. These requirements are that the couplers should be steam-tight; uncouple automatically; have an unobstructed passage for steam; have no movable parts, springs, etc.; hang below the air coupling; have as few projections as possible; be interchangeable; easily coupled; simple, compact and not expensive. Each of these statements is supported by reasons, and the Consolidated Company claims that the only coupler answering to all those requirements is the Sewall coupler.

THE Port Richmond Iron Works, in Philadelphia, for many years operated by I. P. Morris & Company, have been sold to the William Cramp & Sons Ship & Engine Building Company. The works are extensive, and have done a large business in engines and other machinery, and will be a valuable addition to the Cramp yards.

A TRIAL of the Servé ribbed boiler tubes was made in the works of Samuel L. Moore & Sons Company, at Elizabeth, N. J. A boiler was first run with plain tubes two days with natural draft and two days with forced draft. The plain tubes were then removed and ribbed tubes substituted, and the boiler was run with the new tubes for two days with natural draft and two days with forced draft. The trial was made under charge of Mr. H. B. Roelker and was very carefully conducted, but at the time of going to press we have not received the full report.

A PLANT is to be erected in Scranton, Pa., for making fuel from culm and coal waste by the Phelps process, which is substantially a water-gas process, and it is expected that its use will be introduced in a number of places throughout the coal region where culm is plentiful, and easily obtained.

THE "Aerator" car, which was recently fitted up by the Pennsylvania Railroad on the plan of Mr. R. M. Pancoast, of Camden, N. J., is now being tried carrying fruit from Florida to Northern markets. In this car the use of ice is not necessary. A similar car fitted up by the Baltimore & Ohio Railroad is now being used carrying oranges from Southern California to Philadelphia. On its first trip the fruit was brought through in very good condition.

THE Scarritt Furniture Company, of St. Louis, has taken a contract to supply the Scarritt-Forney high-back seat for several passenger cars now under construction by the Barney & Smith Company, in Dayton, O., for the Pittsburgh, Shenango & Lake Erie Railroad. These are very handsome cars. Scarritt-Forney seats are also being furnished for two first-class cars now being built for the East Louisiana Railroad.

THE Baldwin Locomotive Works, Philadelphia, have taken a contract to build 48 engines for the Northern Pacific Railroad. Of these engines, 40 will be mogul freight engines of the standard pattern of the road, and the other eight will be consolidation engines with 22 × 28 in. cylinders for the mountain divisions.

THE new yards of the Chicago Ship Building Company, at South Chicago, have a front of 1,400 ft. on the Calumet River, and cover 21 acres of land. There are three building slips, and between two of these is a powerful steam derrick which is used for delivering material to the vessels under construction. The main building is 570 × 75 ft., and there are a number of smaller shops. The first steamship built was recently launched, as we

have already noted, and another vessel of the same size is nearly completed.

THE Rogers Locomotive Works, Paterson, N. J., have recently completed a large order for mogul engines with 19 × 24-in. cylinders for the Chicago, Burlington & Quincy. They are now building for the same road three decapod engines, with 22 × 28-in. cylinders; these engines have five wheels connected, and a two-wheel truck. They are also filling an order for mogul passenger engines, with 19 × 24-in. cylinders and 60-in. drivers for the Norfolk & Western Railroad.

THE opalite surfacer, made by the Charles C. Phillips Company, Philadelphia, for priming and surfacing car and locomotive work, has been adopted on a number of railroads with very satisfactory results.

THE present sent by the Mason Regulator Company, of Boston, to its friends at Easter was a "fresh egg" packed neatly in a small box. The shell was apparently perfect, but on cracking it the yolk was found to consist of yellow tissue paper, on which was printed a brief reference to the Mason Company's reducing valves, air-brake regulators and damper regulators. The whole device was very neat.

THE life of ordinary roof paints is from two to five years. It is claimed that Dixon's graphite paint, however, will last from 10 to 15 years on outside work. This paint is especially useful in localities where a surface is likely to be corroded by acids and alkalies. An example of its use on a large scale is on the new elevated line of the Pennsylvania Railroad in Jersey City.

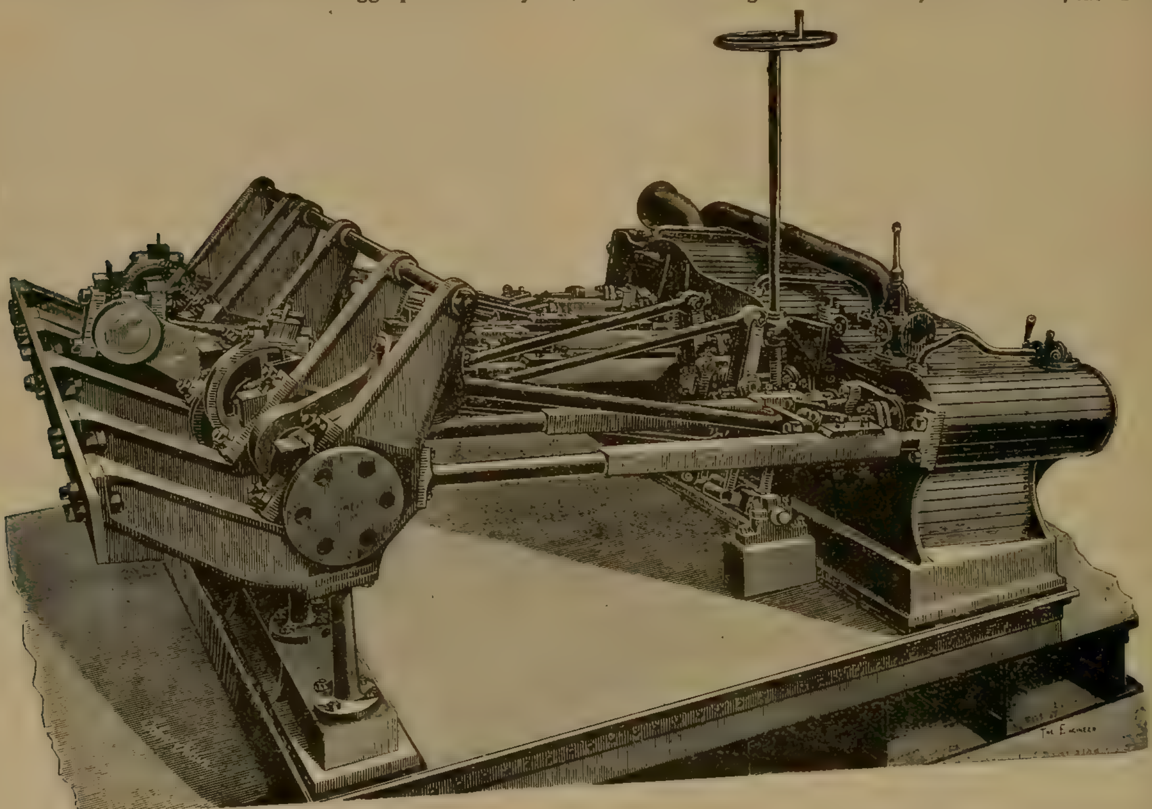
THE Pennsylvania Railroad shops in West Philadelphia are putting in a Thomson-Houston electric welding machine, to be used in boiler work. The car shops last month turned out a total of 92 cars. The paint shop at this place is provided with an elaborate system of ventilation, which has worked very well, not only in keeping the air in the shop pure, but also in assisting the drying of paint and varnish on cars.

THE Toledo Machine & Tool Company, Toledo, O., has bought the entire plant of the Smith & Haldeman Elevator Company, including all patterns, tools, etc., and is now located in the shops on Superior and Oak streets, with a much enlarged capacity for work. In the new shops the company will make punching presses and other sheet-metal tools in addition to the small work heretofore done. The concern was started by G. F. Danielson three years ago, and has been remarkably successful.

THE Harlan & Hollingsworth Company, at Wilmington, Del., is building two iron steamers for the line between Norfolk and Washington. The first of these, the *Washington*, was recently launched. She is 260 ft. long over all; 37 ft. beam moulded; 46 ft. wide over guards; 16½ ft. deep and draws 10 ft. of water. The engine is of the direct-acting inverted triple-expansion type, with cylinders 22 in., 36 in. and 55 in. in diameter and 28 in. stroke. The passenger accommodations are very handsomely fitted up, and the boat has a large capacity for freight. On the trial trip, with 118 revolutions per minute, the ship made 16¾ knots an hour.

DURING March the Schenectady Locomotive Works turned out 35 engines, including sixteen 19 × 24-in. 10-wheel freight and eight 18 × 24-in. 10-wheel passenger, for the Chicago & Northwestern; five 19 × 24-in. 10-wheel freight for the Chicago, St. Paul, Minneapolis & Omaha; one 18 × 24-in. mogul for the Bennington & Rutland; one 18 × 24-in. 10-wheel (completing an order for 25) for the Atchison, Topeka & Santa Fé; one 17 × 24-in. 6-wheel switching engine for the Grand Central Station, New York; one 18 × 24 in. 6-wheel switching engine for the Fitchburg; two 18 × 24-in. 6-wheel switching locomotives for the Northern Pacific Terminal Company.

THE new bridge over the Arkansas River at Ft. Smith, Ark., was completed March 30, when the draw-span was swung into position. This bridge was built by the Union Bridge Company, and is 2,370 ft. in length over all.



TRIPLE-EXPANSION ENGINE FOR SIDE-WHEEL RIVER STEAMER.

## A Light Side-Wheel Engine.

THE accompanying illustration, from the London *Engineer*, shows an engine built by the Southampton Naval Works for a light side-wheel steamer, intended to run on the Nile. The engine is of the triple-expansion type, with cranks set at an angle of 120°, the cylinders being 12½ in., 20 in. and 30 in. in diameter, by 36 in. stroke. The high-pressure and intermediate cylinders have piston valves, the low-pressure a plain slide valve, each worked by a link motion. The air, feed and bilge pumps are all in one casting; they are worked by levers and links from the low-pressure cross-head. The condenser is entirely separate, and is cylindrical in form, of copper.

The general design of the framing and the arrangement of the engines on the flat bottom of the boat are well shown in the engraving. The wheels are of the feathering type, and are 6 ft. 9 in. in diameter.

Steam is supplied by two boilers of the locomotive type, 42 in. in diameter and 15 ft. long, working at a pressure of 160 lbs. They will work under forced draught, on the closed ash-pan principle.

There will be a small engine for running the dynamo for the electric lights. This engine will take steam from a smaller boiler, also of the locomotive type.

## OBITUARY.

CAPTAIN THOMAS H. LAPSLEY, who died at Braddock, Pa., April 10, was well known from his long experience in rolling-mill work. He was 72 years old, and had been Superintendent of the Edgar Thompson mill ever since these works were started. He had suggested and made many improvements in his department.

J. EDWARD LARKIN, who died at Havre de Grace, Md., April 11, aged 60 years, was born in Yarmouth, Mass., and entered the service of the Philadelphia, Wilmington & Baltimore Railroad under the late President Felton, and had been connected with the road ever since. For a number of years he had charge of the bridges on the road, and had a part in designing a number of the present structures. At the time of his death he was in charge of the bridge over the Susquehanna between Havre de Grace and Perryville.

## PERSONALS.

R. W. BAXTER has been appointed Superintendent of the Ohio Division of the Baltimore & Ohio Railroad.

J. M. JOHNSON, for some time past Engineer of the Louisville Bridge & Iron Company, has been appointed President also.

ROBERT QUAYLE, recently on the Chicago & Northwestern, is now Master Mechanic of the Milwaukee, Lake Shore & Western Railroad.

P. C. SNEED is now Superintendent of the Chicago Division of the Baltimore & Ohio Railroad, succeeding F. H. BRITTON, who has resigned.

ALFRED H. RAYNAL, lately with the Richmond Locomotive Works, has been appointed Superintendent of the works of the Samuel L. Moore & Sons Company at Elizabeth, N. J.

RICHARD RANDOLPH, late Consulting Engineer, has been appointed Chief Engineer of the Baltimore Belt Railroad in place of SAMUEL REA, who has resigned on account of ill health.

T. F. WETHERBEE has been appointed General Agent of the Westinghouse Machine Company at Durango, Mexico. He has been for some time engaged in mining operations in that vicinity.

C. C. ELWELL is now Engineer of Maintenance of Way of the Philadelphia Division, Baltimore & Ohio Railroad, succeeding W. A. PRATT, who has been transferred to the Pittsburgh Division.

JAMES H. WINDRIM, for some time past Supervising Architect of the Treasury Department, has resigned that office, and has accepted the position of Director of Public Works of the City of Philadelphia.

W. M. HUGHES, Assistant General Manager of the Keystone Bridge Company, has been appointed Engineer of Construction for the buildings for the Columbian Exposition. He will have his office in the Rookery Building, Chicago.

WILLOUGHBY J. EDBROOKE, of Chicago, has been appointed Supervising Architect of the Treasury Department. He is an architect of considerable experience, and was at one time Commissioner of the Chicago Building Department.

E. DICKINSON has resigned his position as General Superintendent of the Trans-Ohio lines of the Baltimore & Ohio Railroad. He returns, as Assistant General Manager, to the Union Pacific, from which road he went to the Baltimore & Ohio.

W. M. MITCHELL, recently appointed Railroad Commissioner of Kansas, has been a railroad man for 20 years, serving as brakeman, fireman, station agent and conductor. He was recently a conductor on the Atchison, Topeka & Santa Fé.

HENRY GOLDMARK has been appointed Consulting Bridge Engineer of the Kansas City, Fort Scott & Memphis Railroad. He has his office in Kansas City, Mo. Mr. Goldmark had charge of the building of the bridge over the Arkansas River at Little Rock.

CAPTAIN GEORGE C. DICKINSON, C.E., late Division Engineer on the Hudson Suspension Bridge & New England Railroad, has been appointed Chief Engineer of the Broadway & West Virginia Railroad; his office is at Broadway, Rockingham County, Virginia.

NAVAL CONSTRUCTOR R. W. STEELE, U. S. N., has been ordered from Philadelphia to the Mare Island Navy Yard, where he will relieve Naval Constructor Fernald, who goes to the New York Yard. Mr. Steele has been on duty at the Cramp yards for several years.

JOHN HICKEY has been appointed Superintendent of Motive Power of the Northern Pacific Railroad. Mr. Hickey has been for several years Master Mechanic of the Milwaukee, Lake Shore & Western, where he has made a reputation as a master mechanic of ability and judgment.

MAJOR N. S. HILL, formerly for many years Purchasing Agent of the Baltimore & Ohio Railroad, is now in charge of the construction of an extension of the West Virginia Central & Pittsburgh Railroad, from Elkins, W. Va., to Bealington. C. H. LATROBE is Chief Engineer of the road.

OSCAR SAABYE, C.E., has resigned his position as Assistant Engineer of Maintenance of Way of the Roanoke Division, Norfolk & Western Railroad, and has entered into partnership with CLARENCE COLEMAN, C.E. They will conduct a general civil and mechanical engineering business, and have established their office at Room 12, Moorman Building, Roanoke, Va.

NAVAL CONSTRUCTOR WILLIAM L. MINTONYE, U. S. N., has been detached from the New York Navy Yard, and ordered to duty at the Boston Navy Yard. He is relieved at New York by NAVAL CONSTRUCTOR FRANK S. FERNALD, who has been for some time past at the Mare Island Navy Yard. Mr. Mintonye has been on duty at the New York Yard for several years, and has had immediate charge of the work on the *Maine* and other new ships.

## PROCEEDINGS OF SOCIETIES.

**General Time Convention.**—The spring meeting of the Time Convention was held in New York, April 8, with a fair attendance, and the usual routine business was transacted.

The Committee on Car Service made a report dealing chiefly with the Demurrage Question, and giving some account of the experience reported by the Car Service Association.

The Committee on Train Rules made a report recommending some slight changes in the present standard rules.

The Committee on Safety Appliances made a report of progress, giving statistics obtained from various roads, principally on steam heating, but making no recommendations.

The new rules reported at the last session were presented and adopted; and it was resolved to change the name of the organization to the American Railway Association. It was decided to hold the next meeting October 14.

The following officers were elected for the ensuing year: President, H. S. Haines; Vice-Presidents, H. F. Royce, Lucius Tuttle; Secretary, W. F. Allen; Executive Committee, G. W. Stevens and C. W. Bradley.

President Haines then made his annual address, which was principally devoted to the training and discipline of railroad men.

**American Water-Works Association.**—The annual meeting began in Philadelphia, February 14, with a large attendance. At the opening session the President made his annual address, calling attention to the importance of the work.

At the business session the report of the Committee on Cast-iron Water Pipes was read, describing the defects commonly found in such pipes, and recommending a uniform system of tests. Other papers read were on the Philadelphia Water-Works, by E. Geyelin; Steel Water Pipe, by J. R. Dunkin, and the Columbus Water-Works, by A. H. McAlpine, and Animal and Vegetable Matter Effecting Water Supply, by Professor Leeds.

In the evening a reception to the members was given at the rooms of the Manufacturers' Club.

The papers read on April 15 included a number of much interest, among which were Water-Works, by Charles Bush; Water Pressure Gauges, by C. A. Hague; Hydraulic Elevators,

by B. F. Jones; Flow of Water in Pipes, by Joseph B. Rider; Water Rates, by H. G. Holden, and others. In the afternoon the members were taken through Fairmount Park and to the Philadelphia Water-Works.

On April 16 a considerable part of the time was devoted to the discussion of questions submitted by members, and several papers were read, including the Purification of Water by Metallic Iron, by Dr. Henry Leffman; Private and Public Works, by E. W. Moss; and Water Motors, by S. E. Babcock.

The meeting on April 17 was devoted to the usual routine business. Mr. J. M. Diven was elected President, and J. H. Decker Secretary. It was resolved to hold the next convention in New York.

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**Master Mechanics' Association.**—The Committee on the Purification of Feed-Water requests information from all members who have tried various devices, chemical and mechanical, for this purpose. The Chairman of this Committee is W. T. Small, St. Paul, Minn.

The Committee on Examination of Locomotive Engineers and Firemen requests information as to the methods adopted on different roads, whether examination is required, and what plans are employed? The Chairman is Mr. W. H. Thomas, Knoxville, Tenn.

The Secretary has issued a reminder to members as to the importance of their answering circulars as fully and as promptly as possible, in order that the committees may be able to make full and proper reports.

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**Master Car & Locomotive Painters' Association.**—The Advisory Committee has prepared the following list of subjects and queries for the annual convention in Washington, September 8, and they are issued in a circular by Secretary R. McKeon:

SUBJECTS.

1. Is there a chemically pure soap that can be safely used for the purpose of cleaning the outside varnished surface of the Railroad Passenger Coach while in service? stating soap, results and method of cleaning.

2. As a question of economy and durability, should Rough stuff be discarded on the outside surface of a Railroad Passenger Coach? If so, what materials and methods of application will best answer the requirements of this class of work, durability being the main consideration?

3. According to the practical experience and ideas of Railroad Car and Locomotive Painters, can a new locomotive receive a durable finish in 10 days, stating method and materials used?

4. As an Associated Body, can we exert an influence on purchasing power that would remedy where necessary the quality of materials furnished? An item of great importance when viewed from the standpoint that the best procurable is the most economical, as demonstrated through practical experience in the Railroad Paint Shop.

5. How should the New Wood Head-Lining material of a passenger coach be treated to prevent the finished surface from becoming destroyed from decay of filler, grain raising, etc., due to the interior heat and moisture of a passenger car?

6. Are Railroad Companies benefited through the Association of Master Car & Locomotive Painters? Essay.

7. Reports of committee of 12 appointed on geographical interchange of test panels painted and exposed for a period of 10 months in the extreme different climatic sections of the country.

QUERIES.

1. Would it be advisable to form a Bureau of Information in connection with our Association?

2. Do you use part or all shellac on the hard wood inside finish of your passenger cars?

3. How do you prepare your stack blacking for Locomotives while in service?

4. What materials do you use and how long do you take to paint your Freight Cars?

5. As an item of shop economy, in what manner can you keep your paint stock and brushes in the most serviceable state?

6. What is the best formula for preparing floor paint for passenger cars?

7. What are your views concerning the piece-work system for the Railroad Paint Shop?

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**American Society of Civil Engineers.**—At the regular meeting, April 1, Mr. J. Foster Crowell presented a paper on the Ravine du Sud, Haiti, and Mr. W. E. Worthen presented a paper on the Concrete Sewer at Mt. Vernon.

A motion was made and carried requesting the Board of Directors to keep the rooms of the Society open every evening except Sunday.

The tellers announced the following elections: *Fellow*, Edwin D. Adams, New York.

*Members:* Job Abbott, New York; Francis C. Gamble, Victoria, B. C.; Charles A. Wilson, Toledo, O.

*Associate Members:* William F. Jordan, Rochester, N. Y.; Levis P. Pennypacker, Clement I. Walker, New York.

*Associates:* S. G. Comfort, Chester, Pa.; J. R. Dunn, W. C. Oastler, New York.

*Juniors:* W. E. Belknap, P. Smith, Jersey City, N. J.; E. J. Chibas, Pittsburgh, Pa.; L. B. Jenckes, South Manchester, Conn.; A. H. Wood, National City, Cal.; J. C. L. Rogge, New York.

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At the regular meeting, April 15, the Secretary read a paper by Mr. A. M. Hawks on the Automatic Refrigerator System at Denver, describing the plant there, which has been in operation for two years successfully, and which is on the ammonia system.

Mr. C. P. Bassett read a paper on the Sewage Disposal at East Orange, describing the new works in that place.

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**Engineers' Club of Philadelphia.**—At the regular meeting, March 17, the tellers reported that the new Constitution and by-laws had been adopted.

The Secretary presented notes on the Mississippi River Discharge, by J. J. Hoopes; notes on Street Cleaning in Washington, by C. B. Hunt, and a description of the Reinforcement of Foundation in a Draw-bridge Pier, by Howard Constable. The subject of Street Cleaning on Asphalt and other smooth pavements brought out some discussion, and the Committee on Information was requested to report to the Club on the practice in this matter in various important States.

Mr. Rudolph Hering continued his paper on the Corrosion of Iron and Steel, and referred to galvanic action as a very common cause, giving the results of experiments made in this country and in England, which established the fact that corrosion was much more rapid when galvanic action took place than otherwise.

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At the regular meeting, March 21, the Secretary announced that the Directors had elected David Townsend Vice-President in place of S. M. Prevost, resigned, and S. H. Chauvenet an additional Vice-President, in accordance with the new Constitution. Mr. T. Carpenter Smith was elected Treasurer.

The appointment of the following standing committees was announced:

*Finance:* P. G. Salom, F. H. Lewis and S. H. Chauvenet.

*Membership:* David Townsend, P. G. Salom and S. H. Chauvenet.

*Publication:* Rudolph Hering, John C. Trautwine, Jr., and Professor H. W. Spangler.

*Library:* George S. Webster, Rudolph Hering and P. G. Salom.

*Information and Entertainment:* H. W. Spangler, George S. Webster and F. H. Lewis.

*House:* F. H. Lewis, John C. Trautwine, Jr., and David Townsend.

The Secretary presented for Mr. Harry B. Hirsh an illustrated description of an Iron Sewer Template which had been used in the construction of a cement sewer.

Mr. Strickland L. Kneass presented notes on the Discharge of Steam into the atmosphere through tubes of different shapes, with pressures from 30 to 120 lbs. per square inch.

The results showed that for all pressures above 25 lbs. the velocity of discharge at any given section of a correctly proportioned tube was practically constant; and that under the same conditions the flow of weight was almost directly proportional to the initial pressure.

A simple formula, comparing very closely with observed results, was given for determining the weight of steam discharged per second from an orifice, in terms of the initial density of the fluid.

There was some discussion of this paper.

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At the regular meeting, April 4, Professor H. W. Spangler called the attention of the club to the fact that while steam passes through an orifice at approximately a constant velocity, if an opening is made below the water level of a boiler the quantity of water passing out under any pressure in unit time is prac-

tically constant. This is due, of course, to the fact that as the water passes from the boiler into a passage in which there is less than boiler pressure, a portion of the water is converted into steam, and while the velocity in this case is different for different pressures, the total quantity of water is practically the same at all pressures. In other words, as long as the pressure in the boiler is practically constant, the time of emptying the boiler is always the same through the same orifice. This was further discussed.

Mr. Thomas G. Janvier read a paper on the Engineering Features of the Road Question, which was followed by some discussion.

A paper was presented for Mr. C. R. Claghorn on the Alabama Coal Fields. This described the three principal fields with their characteristics, and the quality of coal taken from them.

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**Engineers' Society of Western Pennsylvania.**—At the regular meeting in Pittsburgh, February 17, Charles A. Camp, E. E. Means, Emil Hallgren, W. H. Kemler, J. Branne, J. M. Deforth, E. K. Scott, James B. Hardie and George Jewett Hicks, were elected members of the Society.

There was a long and very interesting discussion on Mr. C. F. Scott's paper on Electrical Mining Machines, in which nearly all the members present took part, and many interesting facts were brought forward to show the advantages of the use of electricity in operating machinery underground.

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**Engineers' Club of Cincinnati.**—At the regular meeting, March 19, A. A. Daniels, A. O. Elsner, F. W. Wrampelmeier, William E. Dowson, William H. Rabbe and Henry Dreses were elected to membership.

The question, Will a cut of 5,000 cubic yards make a fill of 5,000 cubic yards after a haul of from 500 to 1,000 ft.? was discussed at considerable length.

The paper for the evening, by W. H. D. Totten, comprised a description of the plants of the Edgar Thomson and the Homestead Steel Works of the Carnegie Association, of Pittsburgh.

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**Civil Engineers' Club of Cleveland.**—The eleventh annual banquet of this Club was held at the Stillman House, in Cleveland, March 17, about 200 guests being present. The banquet was much enjoyed, and still more pleasure was derived from the speaking after dinner. The different toasts and the gentlemen who responded to them were: "The Starry Heavens," Professor C. S. Howe; "The Earth," Dr. Carl von Kline; "Electricity," Professor Cady Staley: "The Air," Mr. C. P. Leland; "Iron and Steel," Mr. S. T. Wellman; "Aluminium and Brass," Mr. W. R. Warner; "Stone and Brick," Mr. John Eisenmann; "Wood," Mr. James Ritchie. The regular speaking was followed by a number of volunteer toasts.

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At the regular meeting, April 14, Frank R. Lander was elected a member. The Programme Committee reported arrangements for meetings for the ensuing year.

Professor Charles H Benjamin read a paper on the Education of the Mechanical Engineer, advocating practical as well as theoretical training. This was generally discussed by members present.

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**Civil Engineers' Society of St. Paul.**—The regular meeting, in St. Paul, April 6, was the third joint meeting of the St. Paul and Minneapolis Societies. Mr. F. W. Cappelen read a paper on the Minneapolis Suspension Bridge. The first bridge across the Mississippi River was a suspension bridge of 560 ft. span, built in 1854. This was replaced by the structure described in the paper in 1876, and it in turn was taken down to make room for the present steel-arch bridge, the wood-work being completely wrecked by dry rot. The cables were removed wire by wire, each one having been pulled from its place and coiled on a drum by steam power at an average cost of 20 cents per wire or a trifle more than 0.4 per pound. The total length of wire thus wound was 1,421 miles. The cost of demolishing the bridge was $11,000. Mr. Cappelen demonstrated that the loaded cables assumed the form of a parabola rather than the catenary. The anchorage irons, although bedded in cement, were found to be deeply corroded.

Discussion of the paper brought out the fact that wooden trusses in the Northwest are commonly built of green lumber, which should not be painted, except at the joints, until thoroughly seasoned, and that oak keys for pine timbers may be wrapped in tar paper to advantage.

**Montana Society of Civil Engineers.**—A special meeting was held in Helena, Mont., February 14, to discuss the question of memorializing the Legislature in favor of the creation of the office of State Engineer. The question was discussed and a letter from the President was read, and it was finally resolved to appoint Mr. W. A. Haven to report to the next meeting the proper action to be taken.

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An adjourned meeting was held in Helena February 28. The Committee appointed at the previous meeting reported that it was not expedient to petition the Legislature at the present session, as there does not appear to be any pressing need for such an office, although without doubt the time will come within a few years. It was recommended that a Committee should be appointed by the Society to collect full data as to the office of State Engineer in such States as it exists west of the Mississippi. The report was approved, and the resolution for the appointment of a special committee was passed.

The Secretary presented a report showing that the total receipts for last year were $411 and the expenditures $417.

It was resolved that standing committees on Topics, Library and National Public Works should be appointed for the ensuing year, and other routine business was disposed of.

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**New England Railroad Club.**—At the meeting in Boston, April 8, Mr. Angus Sinclair presented a paper on Inspection of Air-Brakes of Freight Cars, which was generally discussed by members present.

A Committee of three was appointed to report changes in the rules for interchange of freight cars, to be discussed at the May meeting of the Club.

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**Central Railroad Club.**—At the meeting, in Buffalo, April 8, the report of the Committee on Inspection of Repair and Air Brakes was presented. It recommended additions to the rules of interchange covering repairs of brake apparatus. This report was discussed, and a number of other amendments to the rules of interchange were suggested and discussed.

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**Western Railway Club.**—At the regular meeting in Chicago, April 21, the first subject was the discussion of the paper on the Improvements in Locomotive Boiler Construction, read by Mr. Hickey at the March meeting.

The second subject was the discussion of the amendments in the Interchange Rules, the object being to prepare members for the discussion at the Car Builders' Convention.

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## NOTES AND NEWS.

**Amended Rules for Boiler Construction.**—The report of the regular meeting of the Board of Supervising Inspectors of steam vessels, which has just been officially promulgated by the Secretary of the Treasury, introduces some important amendments to existing rules, adapting them to improved qualities of boiler steel plate and methods of application.

In regard to lap-welded flues it is required, in addition to the old rules, that flues 7 in. and not over 16 in. in diameter shall be made in lengths of not over 3 ft., and fitted one into the other and substantially riveted; or in lieu thereof shall be corrugated to a depth of not less than ¾ in. outwardly, and at a distance of not over 3 ft. between such corrugations: *Provided* such corrugations are made without in any manner reducing the thickness of the material in the flue at the points of corrugation to less than the least thickness of the material in the body of the flue, or that such flues are made in sections of not over 3 ft. in length, and flanged to a width of not less than 2 in., and riveted substantially together with a wrought-iron ring, having a thickness of material of not less than the thickness of material in the flues, and a width of not less than 2 in, riveted between such flanges. The thickness of the lap-welded flues shall not be less than the product of the constant 2.20 multiplied by the diameter of the flues in inches, which will express the thickness in hundredths of an inch.

For cylindrical boiler flues over 16 in. and less than 40 in. in diameter the following formulas shall be used in determining the pressure allowable: Cylindrical boiler flues over 16 in. and not over 40 in. in diameter shall be made in lengths of not over 3 ft., fitted one into the other, and substantially riveted, or flanged to a depth of not less than 2 in. and riveted together with a good and substantial wrought-iron ring between each joint, and no such ring shall have a thickness of less than ½ in., nor a width of less than 2 in., and the maximum steam pressure per square inch allowable shall be determined by the formulas given.

The amended rules are very complete and give full directions as to Government requirements for coil and pipe boilers, constructed in all parts of wrought iron and steel plates.

**Repairing Wet Arches.**—In a recent number of the *Centralblatt der Bauverwaltung* was an account of a very satisfactory method of repairing damp tunnel arches, employed on the Trier Division of the Prussian State Railways by Herr Blum, the author of the article from which the following abstract is taken: The plan of the work was very simple, being merely

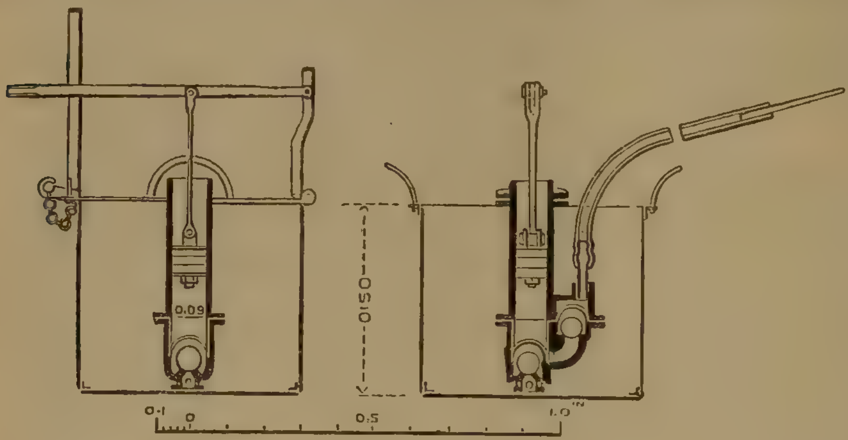



FIG. 1. FIG. 2

the injection of cement through cracks and holes in the masonry, which became practically a monolithic mass as soon as the cement had hardened. This method of drying a tunnel was never employed until a careful examination of the surface of the ground had been made, and it was found impossible to remedy the faults by draining.

Where drainage will not suffice, the tunnel walls are carefully examined, and all joints not tight are scraped out to a depth of 2 in. and caulked with about 0.8 in. of oakum, and the remaining void filled with cement in the usual manner.

At the same time that this work is being done, workmen are boring the 1½ in. holes through the masonry into which the current is to be injected. This cement is intended to fill not only the outer parts of the joints, but also to cover the whole exterior of the masonry if there are air spaces about it. As the work of boring these holes is expensive, care should be taken that they are driven at the most advantageous points. Experience has shown that a distance of 3 ft. between the holes is as great as is consistent with good results; in very wet places this should be reduced by a third. Whether the holes are best driven through the stone or in the joints depends entirely upon the nature of the arch, especially the character of the stone, and must be determined independently for each case. Where soft stone is employed, it is generally better to drill through the voussoirs, especially if their faces were not dressed flat, since the holes through the joints will be very rough and uneven in such cases, and the additional labor in injecting the cement will more than counterbalance the slight saving in boring.

The semi-fluid cement that is forced into the crevices is composed of five parts of cement and four of water. The injecting pumps are shown in figs. 1 and 2. The pump barrels are of brass, and the nozzle at the end of the rubber pipe is copper. The price of the apparatus, with 10 ft. of 2 in. rubber pipe, was about $42. With a wooden tub the cost would be considerably less. The cement must be carefully stirred, and it is necessary to clean the pumps thoroughly at least once every day. The cement is injected at the crown first by thrusting the copper nozzle through the oakum caulking, and pumping until the material shows in a neighboring hole or joint. Whenever the cement appears in the joints the openings are carefully plugged, the pumps stopped, and moved to the next hole. The work is usually done by means of scaffolding mounted on wheels, running on the track in the tunnel. As soon as the crown has been made impervious the sides of the tunnel become damp. This is best remedied by breaking small openings through the tunnel sides, and making, if possible, small drains, filled with stone, up toward the crown on the outside of the masonry. The cost of the work varies greatly with the condition of the tunnel, varying in several cases cited from $1.56 to $3.13 per square yard of surface.

**Towing on Canals.**—At a recent meeting of the German Railroad Association in Berlin, M. Wiebe presented some notes on the trials made on the Oder-Spree Canal in the mechanical traction of boats. The two divisions of the canal having a total length of about 3½ miles, the trial was made with a cable kept in continuous movement, to which the tow-ropes from the boats could be attached. This cable was driven by stationary engines and carried on pulleys fixed on posts, supports of different forms being tried. In one respect the results were satisfactory, as boats could be easily attached to the cable and detached from it. The most serious difficulty was the tendency of the cable in movement to turn around on its axis and so entangle the tow-ropes. No arrangement tried could prevent this, and it seemed sufficiently difficult to prevent further development of this system.

On the same canal towing by a locomotive running on a track on the towpath was also tried. As it was considered that the tendency would be to bring the engine from the track, a car was provided to which the tow-rope could be fastened. This car was heavily loaded, so as to bring the center of gravity as near the ground as possible. The track upon which it ran was a light one, similar to those used in mines. The results in this respect were satisfactory; on occasion a speed of about eight miles an hour was reached, but from three to four miles is sufficient for ordinary towing. For large boats loaded with coal it was found that the strain upon the tow-rope was about 1,700 lbs. in starting, but when the boat was once in motion the work was much less. In convex curves it increased, but it diminished on concave curves. A grade in the track did not make any difference in the work necessary to move the boat.

**Ancient Ship Railroads.**—If a search were made among the papyri at the British Museum, evidence would be found that the Egyptians were in the habit of transporting vessels overland across the isthmus of Suez, and it is, indeed, more than probable that they did so. Tradition records that 23 centuries ago a true ship railroad, with polished granite blocks as rails, existed, and was worked across the Isthmus of Corinth, where the construction of a ship canal has just now only been partly effected and subsequently abandoned for financial considerations. In 1718 the well-known Count Emanuel Swedenborg constructed a road and "machines" for carrying laden vessels from Stromstadt to Iddefjord in Sweden, a distance of 14 miles across a rough country, and the successful use of this work by Charles XII., during the siege of Frederikshall, led to Swedenborg being regarded not only as a national benefactor, but as a mechanician of no mean ability for at least a century after his death.

The vessels transported in all the above cases were, no doubt, small in size and weight compared with modern vessels. Necessarily, also, any vessel carried in our own times on an ordinary railroad must be comparatively small, or it would not be able to pass under bridges and through tunnels. Within the latter limits, however, no practical difficulty whatever has been found in sending small vessels by rail at the usual speed of good trains. The Dutch have shifted torpedo boats from one part of the coast to another on railroad trolleys, and Mr. Donaldson, the torpedo-boat builder, some time since forwarded his steam yacht from the Thames to the west coast of Scotland by rail, having, of course, removed masts, funnel, and all deck hamper to enable her to squeeze through tunnels.—*Fortnightly Review, London.*

**The Road Question.**—In a paper recently read before the Engineers' Club of Philadelphia by Mr. Thomas G. Janvier, on the Engineering Features of the Road Question, the author said that this branch of the road question should be divided into three parts: 1. Location; 2. Preparing the road bed; 3. Laying the pavement.

*Location.*—The item of expense should be well considered. In this connection, grading, land damages, etc., should not be overlooked. The line should be as direct as possible, remembering that a slight deflection to the right or left or an easy curve might save considerable expense in the matter of excavation, embankment or bridging. The grades should be made as easy as possible, not exceeding 7 ft. per 100, or less than 8 in. per 100 ft. Excessive excavations and embankments should be avoided.

The full width should not be less than 40 nor more than 60 ft., but the paved portion need only be from 18 to 24 ft.

The road-bed, or sub-grade, should have the same shape as finished grade.

*Pavement.*—If intended for very heavy travel, the Telford

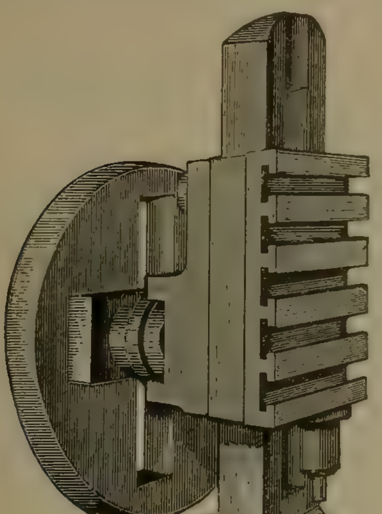
pavement should be put down, but, if for ordinary travel, McAdam will answer. The difference in cost of these two pavements is but slight, and the Telford being much superior, should be given the preference.

A Telford or McAdam road thoroughly constructed and properly maintained will never need reconstruction. The best system of maintenance is that of constant daily attention and repairs. All dirt roads intersecting a paved road should be paved several hundred feet from the intersection in order that as little mud and dirt as possible shall be carried on to the paved road.

Important points to be observed for keeping a road in good condition :

1. All dirt and mud removed as frequently as possible.
2. The entire drainage system carefully maintained.
3. Constant daily repairs and patches wherever and whenever ruts or depressions begin to show.
4. Careful sprinkling three or four times a day in dry weather.
5. The frequent use of a 2½-ton roller.

**An English Lathe Attachment.**—The accompanying illustration represents an appliance to be attached to lathes and other similar tools for obtaining a vertical reciprocal motion. It is made by Mr. F. M. Rogers, 21 Finsbury Pavement, London, E. C. The action of the apparatus is simple, and will be understood from the illustration. A vertical standard, which can be bolted to the lathe bed, has free to slide upon it a grooved face plate. This can be moved up and down by means of a roller or guide block mounted upon a pin bolted to the chuck plate of the lathe. The pin is free to move backward and forward in the roller path formed on the back of the slide, the length of stroke, of course, depending upon the distance between the pin and the mandrel center. The appliance, which is likely to be found particularly useful in small shops, can be used for a variety of purposes. By placing a cutting tool in the slide rest of the lathe, and feeding either by hand or automatically, a piece of work fixed to the reciprocating plate can be either planed or shaped, or the appliance could be used for punching or shearing if desired.—*Industries.*



**Wind Observations on the Eiffel Tower.**—The *Revue Scientifique* (Paris) gives the result of observations taken on the Eiffel Tower of the force and direction of the wind, chiefly relating to ascending and descending currents ; that is to *vertical* as distinguished from *horizontal* movements of the air. The greatest speed of a vertical current yet observed was during the storm of November 23, 1890, when it reached 34 meters per second, or about 76 miles an hour, the speed, however, being variable. The observations have not been continued long enough to make it safe to formulate any general rules, but M. Angot, who has had charge of the observations, notes the following general results ;

1. *Descending* currents are less frequent than ascending currents, and their speed is always less.
2. Every rapid and prolonged fall of the barometer is accompanied by strong *ascending* currents, of a speed of 2 to 4 m. per second, or 4½ to 9 miles an hour. Under these conditions the force of the horizontal current is usually considerable and the sky clouded, so that radiated or reflected heat from the tower itself is not likely to cause the current. Moreover, the same general results were obtained at night as by day.
3. There is no relation between the horizontal and vertical components of the wind. During storms the vertical speed increases more often during the lulls which follow violent blasts.
4. When the barometer rises after a fall, the vertical movement of the air is upward quite as often as downward.
5. Thus far the longest periods of descending currents observed have been when the barometer was rising rapidly, or during long periods of high barometer. In the latter condition there are frequently alternations of ascending and descending currents, each lasting several hours.

**A New Tunnel under the Thames.**—If the London County Council follows the advice of Sir Benjamin Baker we shall have underneath the Thames at Blackwall one of the largest tunnels of its kind ever constructed. The plan is similar to that which has been adopted in the construction of the City & South London Electric Railway, but whereas the tunnels of that company are 10 ft. in diameter, the one projected at Blackwall has an outside diameter of 27 ft. and an inside of 23 ft. The nearest approach to these dimensions are the Hudson River Tunnel, which is 20 ft. in diameter, and the Sarnia Tunnel, which is 21 ft. In September last Sir Benjamin Baker, under instructions from the County Council, visited these American works, as they present conditions somewhat similar to those which exist at Blackwall, in order to judge of the advisability of adopting the same plans. As the result of his personal study on the spot, the eminent engineer has given it as his opinion that the system is perfectly practicable, and that it should be the one adopted.

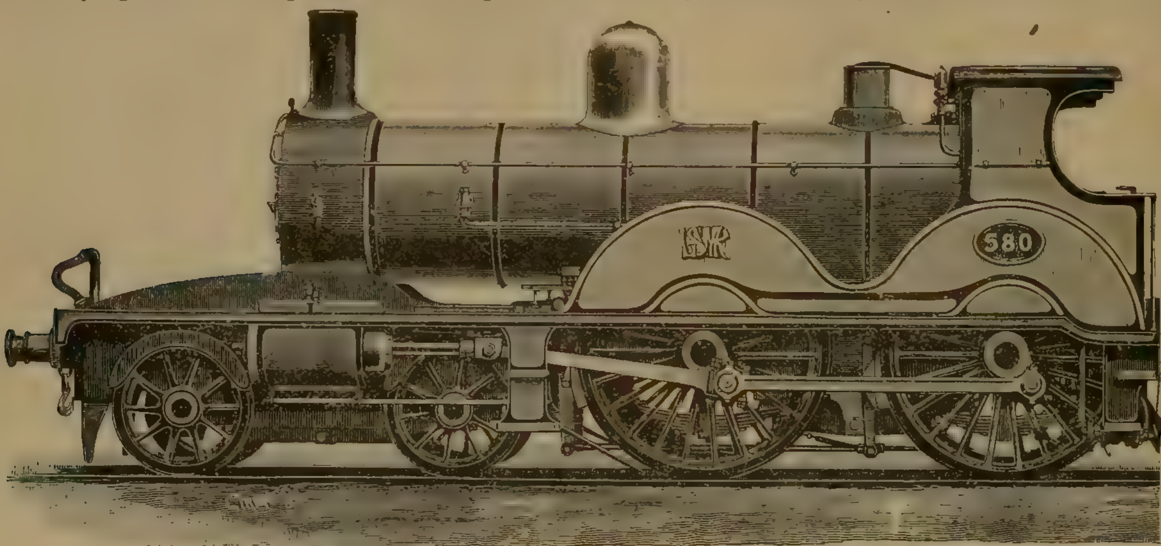
Those who have read descriptions of the South London subway will understand the nature of the work. The tunnel is practically an iron tube built up in segments, which are firmly bolted together. The excavation of the ground is effected by means of a shield with sharp cutting edges, which is advanced 20 in. at a time by means of powerful hydraulic presses. While the soil is being taken out the iron segments are built up, and the shield is then advanced another 20 in. In this way a continuous ring of cast iron is formed. At first the Hudson River Tunnel was driven under the bed of the river without a shield, but in consequence of the inflow of river mud and water, which brought the works to a standstill, the shield was introduced, and the difficulties overcome. In the case of the Sarnia Tunnel the heading had at one point to be driven through soft clay, gravel and sand, but by means of the steel shields and compressed air, progress was made, although at a slower rate than when cutting through the clay. About 5 ft. of tunnel per day was what was accomplished in the gravel, while about double that amount was the average in the clay. It is thus possible by this system of driving to work through any sort of soil, as Mr. Greathead also proved when he came to gravel, sand and water in boring the South London line. At Blackwall there would be no mud, the soil being clay, gravel and sand, so that the conditions would be more favorable on the Thames than on the Hudson. At least 8 ft. of material would remain between the bottom of the river and the top of the tunnel.

Unlike the South London Tunnel, it is proposed to give the one at Blackwall a lining of brick, which, with the iron, would be 2 ft. in thickness. Thus, while the outside diameter would be 27 ft., the inside would be 23 ft. Being in a circle, the whole of the space would not be available for vehicular traffic, but there would be sufficient height for a roadway 18 ft. broad, which would be ample for two lines of vehicles. Many very busy streets in London have less width, and as there will be no interruption from cross traffic the accommodation should be ample. No path is provided for foot passengers, as it would be practically impossible in the space at disposal, and the suggestion is made that they should be provided for either by electric tramways or a smaller and separate tunnel. The Bridge Committee of the County Council, who have the matter in hand, are apparently proceeding very cautiously in the matter. In addition to Sir Benjamin Baker's inquiry, the Chief Engineer has drawn up a report on the subject, and a full-size section of the tunnel is being prepared for the inspection of the members. We may expect in a short time their final decision, and if they should approve the plans we should not have to wait long for a much-needed means of communication between the north and south sides of the river.—*Pall Mall Gazette, London.*

**A Long Tunnel.**—The Centralia drainage tunnel, near Ashland, Pa., has been practically completed. It is one of the longest tunnels in the United States, and was built to drain a number of coal-mines in the Centralia Basin in the anthracite region. The main tunnel is 6,000 ft. in length, and is 7 × 11 ft. in section. Extensions and branches to reach various mines which it is to serve are about 3,800 ft. in length, making the tunnel some 9,800 ft. in all, to which some further additions will be made.

With the completion of this tunnel a number of the local mines can be extended, and it will be possible to continue the working of the celebrated Mammoth Vein, on which very little has been done for some time past on account of the great expense of pumping.

**An English Express Engine.**—The accompanying engraving shows engine No. 580 for the London & Southwestern Railroad, which may be taken as a type of the latest design of English express engine. The general features, it will be seen, are those of the American type, four driving-wheels connected and a four-wheel truck, but it differs from an American engine in having inside cylinders and a plate frame. It is stated that in this engine steel castings have been used wherever possible, but the coupling and connecting-rods are of wrought-iron.



The cylinders are 19 × 26 in.; the driving-wheels 7 ft. 1 in. in diameter, and the truck-wheels 46 in. The boiler is 52 in. diameter of barrel and has 240 tubes $1\frac{3}{4}$ in. in diameter and 11 ft. 4 in. long. The working pressure is 175 lbs. The grate area is 18 sq. ft., and the total heating surface 1,368 sq. ft. The total length of the engine and tender is 53 ft. $8\frac{1}{2}$ in., and the total wheel-base is 44 ft. 3 in. The driving-wheels are spaced 8 ft. 6 in. between centers, and the distance from the center of the main driver to the center of the truck is 10 ft. 9 in The total weight of the engine in working order is 109,200 lbs., of which 42,000 lbs. are carried on the truck and 67,200 lbs. on the driving-axle.

In ordinary work these engines run 84 miles, from Waterloo Station, London, to Salisbury, in 1 hour, 48 minutes, making one stop, the average train being 14 coaches. The usual run is from London to Basingstoke, 48 miles, in 60 minutes, and from Basingstoke to Salisbury, 36 miles, in 48 minutes.

**Flight not Improbable.**—At the recent annual meeting of the Western Society of Engineers, in an impromptu discussion of aeronautics, Mr. Chanute, the well-known engineer, said:

"The principal difficulty hitherto has been the lack of adequate motive power; that is, the want of a sufficiently light motor in proportion to its energy, to accomplish what birds daily perform; but during the past two months announcements have come from three different parts of the world, that very much lighter motors than any now known to exist are being developed and are being made a partial success. From France comes the statement that Commandant Renard, who has charge of the Aeronautical Department of the French Army, and who, as you remember, some years ago accomplished a speed of 14 miles an hour in a navigable balloon, with an engine exerting 9 H.P., and weighing 1,174 lbs., has now developed another motor, from which he obtains 70 H.P., with a weight of but 946 lbs., or a weight of only $13\frac{1}{2}$ lbs. to the horse power.

"From England comes the news that Mr. Maxim, who is celebrated as an inventor of an electric light, and also of that marvel, the quick-firing gun, which fires 100 shots a minute, has invented a motor of 100 H.P., which only weighs 600 lbs. From our own State comes a still more wonderful fairy tale; from Mount Carmel comes the information that a gas motor has been invented which exerts 100 H.P., and only weighs 250 lbs. Now, remembering all the time that the solution of the problem is chiefly dependent on a light motor, if one-half of the story of Mount Carmel be true, and we can obtain 50 H.P. with 250 lbs. of weight, or even if a quarter be true, or, to speak more accurately and professionally, if only the square root of it be true, and we can get a motor of 10 H.P. weighing only 250 lbs., then an enormous step will have been made toward the solution of the problem."

**Expanding Alloy.**—An alloy that expands when solidifying, and therefore is valuable to fill cracks in iron castings, is, according to *Revue Industrielle*, produced by fusing together nine parts of lead, two of antimony and one of bismuth.

**Aluminum.**—At the close of a lecture recently delivered before the Franklin Institute Mr. Joseph W. Richards, said: "Six years ago aluminum sold for $12 a pound, three years ago for $5, to-day it is being sold in England at $1.50, and before this year is out it will probably be down to $1. Aluminum was never before sold as cheaply as it is now. The prospects for cheaper aluminum were never more promising than now.

**Cunard Steamers.**—It is reported in foreign journals that the Cunard Company has placed a contract with the Fairfield Shipbuilding & Engineering Company for the construction of two new steamers, which will be the largest of their class ever built, being, it is said, vessels of 14,000 tons each.

**Ventilating Shaft.**—The North British Railway Company contemplates the erection of a ventilating shaft in connection with the Glasgow Underground Railroad. The railway authorities, it is said, would be prepared to make the shaft of an ornamental character. [Why would it not be well for the New York Central Company to entertain a similar idea?—Editor.]

**Coal Production in India.**—According to a recent Indian statistical statement, the production of coal in all India last year was 2,045,359 tons, of which Bengal gave 1,641.354 tons, the Central Provinces 144,465, Assam 116,676, and the Nizam's territory 59,646 tons. In 1880 the total production was 1,019,793 tons, almost wholly in Bengal; in 1883 it was 1,315,976 tons; in 1886, 1,388,487, and in 1888, 1,708,848 tons. In 1880 the only sources of supply were Bengal and the Central Provinces. The latter yielded 31,928 tons in that year, against 144,465 in 1889. The Assam coal-fields were first worked in 1884, when they gave 16,493 tons, and 116,676 in 1889. Coal was first worked in the Punjab in 1887, and last year the yield in that province was 22 835 tons. The Central Indian coal-field was first worked in 1885, and in 1889 it yielded 56,956 tons, while the Nizam's territory, which gave only 3,259 tons in 1887, gave 59,646 tons last year. On the whole, during the last decade the coal production of India doubled. At the commencement of that period the only fields worked were those of Bengal and the Central Provinces; at the end there were mines in addition in four other provinces and territories. In Bengal the yield increased from 988,565 tons to 1,641,354, and in the Central Provinces it increased nearly fivefold.

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, JUNE, 1891.

AN article which will be found upon another page gives a concise but full account of some careful tests of a compound locomotive made recently upon the Mexican Central Railroad under the direction of Mr. F. W. Johnstone, Superintendent of Motive Power of that road. The manner in which the experiments were carried out is fully given, and the resulting economy in fuel shown to be very considerable. This is a much more important point on the Mexican Central than in many other lines, since fuel is very scarce on its line, is all brought from a distance, and costs the railroad on an average as high as $11 per ton.

The results of these tests have been so successful that the company has ordered six new engines, of the type designed by Mr. Johnstone, from the Rhode Island Locomotive Works, and further proposes to alter some 50 of its old engines to compound as fast as they can be brought into the shop.

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THE preliminary survey has been begun for a water-power canal which is to take water from the Niagara River at Tonawanda, near Buffalo, and to run thence to Lockport, where the projectors expect to utilize the power obtained from the fall. From Lockport it is to run to Olcott, where an additional fall will be obtained before the water is discharged into Lake Ontario. It is expected that some 250,000 H.P. can be obtained. The distance from Tonawanda to Lockport is about 15 miles; from Lockport to Olcott, 12 miles.

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AN expedition to the North Pole by way of the interior of Greenland has been planned by Civil Engineer R. E. Peary, U. S. N., who will undertake the trip with a small party provided with dog sledges of the Eskimo pattern. He believes that in this way, carrying a light load and traveling rapidly, he can penetrate further to the northward than any one has yet been able to do.

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THE Interstate Commerce Commission gave recently a decision of considerable importance in the matter of complaint made by the New York & Northern Railroad Company against the New York & New England Company. The complaint of the Northern was that the New York & New England had refused to unite with it in making a through line to New York, while at the same time it had made arrangements by which the through business from its line was sent entirely over the Housatonic Railroad by way of Bridgeport or Danbury, in spite of the fact that equal facilities, rates, etc., were offered by the Northern Road. The Commission on the evidence and arguments has decided that the New York & New England Company is clearly in the wrong, and while not actually holding that a railroad company is bound to establish a through line, it does hold that it must give equal facilities to all connecting lines, and that it cannot establish a through line with one and not with another, where both reach the same point.

This decision, it will be seen, has a wide application, and if other complaints of similar character are brought under the law may make a great deal of trouble for some companies.

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IRON production for the first time this year shows a slight increase, the figures collected by the *American Manufacturer* giving 231 furnaces in blast with a weekly capacity of 116,600 tons. These figures show no increase in the number of furnaces, but a gain of 3,300 tons in weekly capacity. As compared with May 1, 1890, the decrease is very considerable, the report showing the number of furnaces less by 110 and the weekly capacity diminished by 64,200 tons, a very serious difference. Part of this result has been due to the difficulties in the coke region, which has forced several of the large coke furnaces to shut down, but the greater part is the result of the diminished consumption of iron so far this year. It is believed, however, that the lowest point has been reached, and that from the present time there will be a steady increase.

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THE problem of terminal facilities and connections in Boston has given the managers of the lines entering that city a great deal of trouble. The latest proposition made for its settlement is to connect the various lines by tunneling under the Charles River, the Fort Point Channel and so much of the main harbor as lies between the city proper and East Boston, thus avoiding draw-bridges and all obstructions of the streets. The new plan has already caused much discussion and also much opposition, though at first sight it seems to offer the best solution of the question.

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TWO of the strongest advocates and believers in the possibility of Aerial Navigation have recently been in conference—Professor Langley, of the Smithsonian Institute, who some time since announced his belief in the theoretical advantages, and Mr. Maxim, who has spent a large amount in experiments in this direction. It is understood that Mr. Maxim proposes to build a new machine on a large scale, following his original plans to some extent, but modifying them to meet Professor Langley's views.

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THE only outcome thus far of the new Rapid Transit Commission in New York has been the presentation of a plan for several extensions of the Manhattan Company's elevated lines. These include several short sections intended to reach the North River ferries and to connect the existing lines, and one long line extending from the pres-

ent Sixth Avenue road at Thirty-third Street up the west side of the city.

What action the Commission will take on these plans is not known at the time of writing; but it seems as if it could hardly be favorable. The tendency of the new lines would be to throw more traffic on parts of the existing roads which are already overcrowded, and not to relieve the present trouble at all, except by furnishing additional facilities to some uptown districts at the expense of additional delay and overcrowding for others.

THERE is also talk of third tracks on the existing structures, over which express trains could be run. A third track, however, would not be sufficient for real express travel, and the so-called fast trains could not be much improvement upon the present service. Any elevated system, to be of real use to the city, must show substantial improvements, which the Manhattan's plan does not promise.

THE present elevated railroads were a great improvement on the horse cars; but a system whose maximum speed does not exceed 12 miles an hour, and whose average is nearer 7 or 8 miles, does not give real rapid transit, and that is what the city needs.

Moreover, while the executive management of the elevated roads has been good up to a certain point, and accidents have been rare, there is a wide-spread public dislike to the general management, which it has certainly deserved by its apparent disregard of public convenience, and its scarcely concealed contempt for public opinion. Any new grants to the Manhattan Company will be regarded with suspicion and resisted in every possible way.

A TEST was made of the range and accuracy of the dynamite guns of the *Vesuvius* in Hampton Roads, May 19. The ship was started at an early hour in the morning, and after firing a number of test shots in order to find the ranges, a final test was made by firing nine dummy or unloaded shells, six from one of the guns and three from another, the range varying from one-half mile to a mile, while some of the shots were fired with the ship nearly at rest, and others when it was running at full speed. The accuracy was fairly good, most of the shots striking within 20 or 30 yards of the mark, the average being about 20 yards, while several struck the target directly. It was estimated by the experts present that, had they been fired at a large vessel, nearly every one of them would have struck some part of the ship or so near as to do it serious injury. It is understood that, as far as the range and the handling of the ship was concerned, the tests were fairly satisfactory. Further tests were made on the following day, with very similar results.

It is very noticeable, however, that in all the tests made of the *Vesuvius* so far only dummy shells have been used. Why cannot a fair trial be made with loaded shells and with some more satisfactory target than a buoy? Then a fair estimate could be formed of the offensive powers of the new cruiser.

THE fight between the *Charleston* and the *Esmeralda*—should one take place—will be an interesting test of strength and skill, and may serve to controvert or establish some theories of naval construction. Meantime the *Charleston* has made a very good showing for speed at sea.

## AMERICAN LOCOMOTIVES.

THE *Engineer* of April 24 contains another article on this subject, in which the editor seems to have a confused idea that the Strong locomotive represents American practice, and that Mr. Le Van is a representative American engineer. Now the Strong locomotive is a very ingeniously constructed machine, and it may be better or it may not be as good as the locomotives in ordinary use in this country, but it no more represents the practice here than the Fairly locomotives on the Festiniog Railroad of Wales—with which *The Engineer* at one time was so much infatuated—represents British practice. Perhaps if our contemporary should read a reference to Mr. Le Van in our issue of last month he would not be quoted seriously hereafter.

Is it, we ask, ingenuous in our contemporary to speak of the Strong locomotive as an "intensely American product," and say that it "has always been talked of as superior to any other in existence," and to pretend that it is a representative of American practice? The Strong locomotive is an experiment, and much ingenuity was shown in its design; but in its present stage of development there is not a locomotive superintendent in the country who would recommend its adoption for general use; and it is safe to say that the editor of *The Engineer* knows of its experimental character.

He is silent, however, about the maximum combustion of coal in English and American locomotives, to which reference was again made in our May number. Surely the capacity of locomotives to burn large quantities of coal, when it is of a poor quality, is important in countries where coal is not good.

## TRAFFIC AND SHIPPING ON THE GREAT LAKES.

THAT the traffic on the Great Lakes is very large, every one knows in a general way, but its great importance is not fully appreciated until we meet with some definite figures, such as are contained in one of the latest bulletins issued by the Census Bureau. According to this report the cargo tonnage on the lakes for the season of 1889 was 27,460,200 tons, and as the average voyage was 566 miles, the total ton-mileage was approximately 15,578,360,000 ton-miles. This was equal to nearly 23 per cent. of the total ton-mileage reported by all the railroads of the United States last year.

It is interesting to know the sources of this traffic. From the report it appears that 54.2 per cent. of the tonnage consisted of products of mines and quarries—chiefly iron ore and coal; 23.8 per cent. was lumber; 16.5 per cent. products of agriculture, and only 5.5 per cent. general freight. Three articles—coal, iron ore and lumber—furnish 75 per cent. of the lake freight. Coal was the largest item—7,677,107 tons, or 28 per cent. of the total tonnage.

It is to be expected that the water route will take the larger share of cheap and bulky articles, on which the freight charges form a large proportion of the cost, and that all, or nearly all, of these classes of freight should take that route. The lake steamers, however, do much more than this; while they take a comparatively small share of the grain and other higher priced freight, they really regulate and control the rates on all of this traffic. As long as the water lines are active competitors for the business, all rates must be made with reference to them, and they are a prin-

cipal factor, if not the leading factor, in fixing the transportation charges. In this way their importance extends beyond the actual share of the traffic which they obtain.

As showing the proportion of the total freight traffic which originates on or goes to the different lakes, it is of interest to note that the tonnage of freight passed through the Sault Ste. Marie Canal was 8,288,580 tons, while that passing through the Detroit River was 19,717,860 tons. That is, about 30 per cent. of the total lake tonnage was carried from or to Lake Superior ports, while 41½ per cent. went to or from the ports on Lake Michigan and Lake Huron. This, of course, omits all account of commerce between ports on the same lake, which is a considerable item on Lake Michigan, but not very large on Lake Superior. Over 53 per cent. of the Lake Superior traffic is in iron ore, most of which goes through the Detroit River also, and is delivered at the Lake Erie ports. It is to be noted that these reports do not include the trade to or from Canadian ports.

It is interesting to see in what kind of vessels this great traffic is carried. The evolution of the lake carrier has proceeded very rapidly during the past few years. The sailing vessel has given place to the steamer, and the wooden ship to iron and steel. The typical lake steamer is now of steel, arranged to carry the largest possible cargo on a moderate draft; propelled by engines of the latest type, proportioned for the highest speed possible with a moderate coal consumption, and provided with appliances for quick loading and unloading of freight. Great speed is not aimed at; but as the number of trips which can be made in a season is an important element, some study has been given to determining the point at which the increased fuel consumption will overbalance the gain from shorter and more frequent trips.

The Census bulletin on this subject gives figures for five years past; and a comparison between those for 1886 and 1890 will be interesting, as showing the changes in that period:

| | 1890 | | 1886 | |
|---|---|---|---|---|
| STEAMERS: | No. | Tonnage. | No. | Tonnage. |
| Side-wheel | 42 | 16,949 | 43 | 14,150 |
| Propellers under 1,000 tons | 431 | 154,232 | 335 | 177,402 |
| Propellers between 1,000 and 1,500 tons. | 122 | 151,611 | 72 | 86,728 |
| Propellers over 1,500 tons | 110 | 188,390 | 21 | 34,868 |
| Tugs | 448 | 12,520 | 466 | 11,737 |
| Total steamers | 1,153 | 523,702 | 937 | 324,885 |
| SAILING VESSELS: | | | | |
| Schooners | 577 | 158,620 | 730 | 183,792 |
| Barges | 325 | 144,038 | 330 | 125,975 |
| Total, sailing vessels | 902 | 302,658 | 1,060 | 309,767 |
| Total, all vessels | 2,055 | 826,360 | 1,997 | 634,652 |

Thus, while the increase in total tonnage has been 30 per cent., that in steam tonnage has been 61 per cent. Moreover, it is hardly fair to call barges sailing vessels, since they depend upon tugs or consort steamers for their motive power. The real sail tonnage—the schooners—has decreased 21 per cent. in number, and 14 per cent. in total tonnage.

The increase in average size of steamers is notable. Disregarding the tugs, which of course are not built to carry cargo, and the side-wheel steamers, which are chiefly in passenger service, or carry only local freight to shore ports, the propellers show an increase of 55 per cent. in number, and of 65 per cent. in tonnage; that is, the average tonnage has increased from 698 to 745, a gain of 7 per cent. The great increase has been in steamers of over 1,000 tons. Even so recently as five years ago, steamers over 1,500 tons were so rare as to be notable; now they are too common to excite remark. The increase in size as well as number is great; the average tonnage of propellers over 1,000 tons in 1890 was 1,468 tons against 1,307 tons in 1886.

The change in ship-building material is considerable also, and can best be shown by a brief table, which includes all vessels, steam and sail:

| | 1890 | | 1886 | |
|---|---|---|---|---|
| MATERIAL. | No. | Tonnage. | No. | Tonnage. |
| Steel | 68 | 99,457 | 6 | 6,459 |
| Iron | 39 | 24,673 | 35 | 22,714 |
| Composite | 13 | 13,554 | 2 | 63 |
| Wood | 1,935 | 688,676 | 1,954 | 605,416 |
| Total | 2,055 | 826,360 | 1,997 | 634,652 |

Wood will, of course, continue in use for many of the smaller vessels; but steel is the structural material for the large carriers, and that its use will continue to increase there is little doubt.

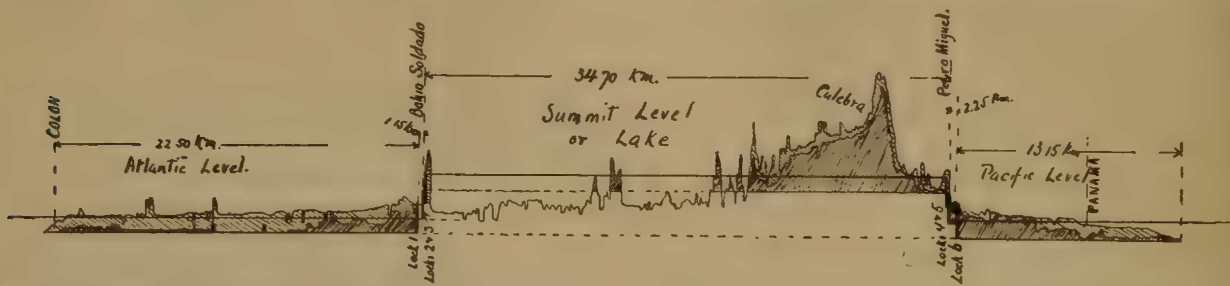
Lake ship-building has reached its present development under peculiar conditions, and to meet the demands of a peculiar trade. It is none the less an excellent development; and our sea-coast builders may perhaps learn some useful lessons from their brethren of the inland waters.

## THE PANAMA CANAL.

THE French papers have recently published an official report from Lieutenant N. B. Wyse, who has been in Panama as representative of the Official Liquidator, or receiver, of the Panama Canal Company. In his negotiations with the Government he has been fairly successful, having made an agreement extending the canal concession for 10 years, the conditions being made, however, that the new company should be organized and have capital sufficient to begin work in February, 1893, and that the property must be protected in the mean time.

In connection with this report Lieutenant Wyse submits an elaborate plan for the completion of the canal, which is based upon studies made under his directions, by MM. Jacquemin and de Soza, Engineers. This plan provides for the construction or rather the completion of the canal with six locks, and for the formation of an interior lake by the construction of a dam across the valley of the Chagres at Bohio Soldado, and another across the valley of the Rio Grande at Pedro Miguel. The level of this lake would be about 30 m. above the average level of the Atlantic at Colon. Proceeding from the Atlantic end of the Canal the first or maritime level would extend a distance of 22.50 km. to the first lock. This lock would have 10 m. lift, and so give admission to a short level 1.15 km. in length, at the end of which two locks, each of 10 m. lift, would raise ships to the level of the artificial lake at Bohio Soldado. The summit level would extend 34.70 km. to the dam at Pedro Miguel through the artificial lake above mentioned, and at the latter place two locks, each of 10 m. lift, would lower vessels to the second short level, 2.25 km. in length, from which a final lock would lower them to the maritime canal on the Pacific end, which is about 13 km. in length. Possibly a tide lock may be needed in addition at Panama.

The advantages of this plan are carefully set forth in the report. The creation of the central lake would largely reduce the amount of excavation required, and would furnish a long stretch of easy navigation, while at the same time it would serve to equalize and to distribute the flood waters of the Chagres, which have been so serious an obstacle to the completion of the canal on its original plan. Moreover, the dams required would not be of excessive size, nor especially difficult of construction, while by these plans the building of the great dam at Gamboa and the works for the diverting the Chagres would be entirely avoided; and as stated above, the amount of excavation required would be very much reduced. The accompanying sketch gives a profile of the canal as completed on the proposed plan, and also shows the amount of work which will still be required, the heavily shaded portions showing the excavation still to be done, while the lightly shaded sections show that which has been already excavated.




The great obstacle, in the opinion of the engineers who made the investigation, still remains the excavation at Culebra, but they believe that the time could be shortened and the expense decreased by a system of tunnels and the transportation of the débris by water. As to the supply of water necessary for lockage, there is no question that it will be sufficient.

The estimated cost of the completion of the canal on this plan, as given by the report, is 120,000,000 francs, which, even accepting all the statements made, seems to be a very low one. Even should it be correct, under the present condition of affairs the company will have considerable difficulty in raising this amount. The new securities could only be placed at large discount, and by the admission of the liquidator no interest could be paid during the construction, while the holders of the old securities must postpone all hope of return until 10 years after the completion of the canal. It will also be necessary to raise a considerable amount to take care of and preserve the property on the Isthmus, and the liquidator has no means in hand for that purpose.

Even taking the French view of the case—which is naturally a sanguine one—the prospects of the canal are by no means favorable; and the probability is that the vast sums already spent will be entirely lost. The success which has so far attended the work on the Nicaragua Canal is another discouraging element for the Panama Company.

## NEW PUBLICATIONS.

EXAMINATIONS BY THE STATE BOARD OF HEALTH OF THE WATER SUPPLIES AND INLAND WATERS OF MASSACHUSETTS; *Part I, The Report on Water Supply and Sewerage.* Boston; State Printers.

This report is the outcome of the act to protect the purity of inland waters which was passed by the Massachusetts Legislature in 1886, and amended two years later. Under its provisions the Board of Health undertook a careful examination, not only of the condition of the water supply actually drawn upon by the cities of the Commonwealth, but also of the possible supplies, especially of those which are sure to be soon brought in use in consequence of the rapid growth of city population in the State. The report, after a short introduction, gives a list and brief description of the water supplies of the cities and towns having water works of more or less importance, accompanied by chemical and biological examinations of the present sources of supply and a description of the river basins. The second part includes a chemical examination of the waters, with the methods of analysis and their interpretation, which is the work of Dr. Drown, Chemist of the Board; which is followed by a report upon Organisms found in the waters. A summary of water supply statistics, giving records of rainfall, flow of streams, etc., is supplied by Mr. F. P. Stearns, Chief Engineer of the Board, who also contributes a chapter on the Pollution of Streams by Sewerage and their Purification. The remaining chapters are devoted to a classification of the drinking waters of the State and to some special topics, such as filtration and the effect of storage upon water, especially in large and deep ponds. The report is accompanied by two maps, one showing the location of the different watersheds and the other the comparative amount of chlorine found in the different streams.

Few public documents can be found which are of more value than this, and few works can be undertaken which are of greater importance to the community than the careful examination of water supplies which has been undertaken by the Massachusetts Board, and which we believe has not been carried out, at least with attempt of thoroughness, in any other State, although it deserves imitations everywhere.

PROFESSIONAL PAPERS OF THE CORPS OF ROYAL ENGINEERS; edited by Captain W. A. Gale, R.E. Chatham, England; published for the Royal Engineers' Institute.

The papers of the Royal Engineers, although many of them are of entirely technical military interest, include some of general value. The present volume is of more general interest perhaps than most of those in the series, since it includes an elaborate paper on Subaqueous Foundations, by Mr. W. R. Kinipple, portions of which have been published in some of the English engineering papers; but it is here given in full with all the drawings and diagrams. Another paper which may be said to have considerable interest to engineers is one by Major R. H. Brown, which describes the methods employed in keeping certain Indian rivers open to navigation during the season of low water. The methods there employed, however, seem to have been in many respects similar to those on our Western rivers; the use of dikes, mattresses, and other devices for directing the current and from preventing shifting in the channel, or upon occasion for partly closing the channel and directing the entire flow of water through one portion of the river-bed, having a strong family likeness to those adopted by our own engineers on the Mississippi and its tributaries.

Among the more technical articles is one on Field Artillery, by General Brackenbury; on the duties of Field Engineers, and on Ships *versus* Forts. The last named is a long and carefully written paper, and many of its conclusions are based upon the experience gained during our own civil war.

## BOOKS RECEIVED.

*Annual Report of the Board of Regents of the Smithsonian Institution, Showing its Operations and Condition to July*, 1889. Washington; Government Printing Office.

*Sixth Annual Report of the Board of Mediation and Arbitration of the State of New York: William Purcell, Gilbert Robertson, Jr., Florence F. Donovan, Commissioners.* Albany, N. Y.; State Printer.

*Postal Savings Banks: An Argument in their Favor by the Postmaster-General.* Washington; Government Printing Office.

*Practice in Iron Bridge Building: by Professor N. A. Beleloubsky.* St. Petersburg, Russia; printed for the Author.

*Compressed Air Production: Rules, Tables and Illustrations Relating to the Theory and Practice of Air Compression and Compressed Air Machinery: by William L. Saunders.* New York; the *Engineering News* Publishing Company (price 50 cents). This is a reprint of a lecture delivered by Mr. Saunders to the students of Sibley College of Cornell University.

*Reports of the Consuls of the United States to the Department of State: No.* 126, *March*, 1891. Washington; Government Printing Office.

*Annali della Societa degli Ingegneri e degli Architetti Italiani. Anno VI*, 1891; *Fascicolo I.* Rome, Italy; published for the Society.

*A Technical Description of the Engineering Building of the Massachusetts Institute of Technology: by Professors Chandler, Lanza, Swain, and Woodbridge.* Boston; reprinted from the *Proceedings* of the Society of Arts.

*Ninth Annual Catalogue of the Rose Polytechnic Institute, with the Course of Study.* Terre Haute, Ind.; printed for the Institute.

*A Treatise upon the Ordinary Draft Appliances of a Locomotive Boiler as Superseded by More Rational Means: by H. A. Luttgens.* Persons interested in this subject can obtain copies of this little book by writing to Mr. Luttgens at Paterson, N. J.

*The Q. & C. Company's Illustrated Catalogue of Railroad Specialties, Chicago.* This includes illustrated descriptions of car doors of different patterns; tie-plates and locking spikes; the globe ventilator; car replacers or wrecking frogs, and the automatic brake-adjuster.

## ABOUT BOOKS AND PERIODICALS.

THE JOURNAL of the Military Service Institution for May has articles on Cavalry in Virginia during the War, by Colonel Crowninshield; Theory of Drift of Rifled Projectiles, by Lieutenant Whistler; Artillery Difficulties in the Next War, by Captain Chester; the Recent Indian Craze, by Captain Dougherty; the New German Rifle and Fire Regulations, by Lieutenant Frost; and a very interesting historical paper on the Red River Dam, by General James H. Wilson.

The steamship article in SCRIBNER'S MAGAZINE for June is on Safety on the Atlantic. Colonel John C. Ropes speaks, in another paper, on the important part played by steam and electricity in the late war. An interesting feature of this number is some remarkable photographs of luminous objects, taken by their own light, and reproduced by mechanical processes directly from the original negatives.

The fifth paper in the series on American Industries in the POPULAR SCIENCE MONTHLY will appear in the June number, and is on the Manufacture of Wool. Another article of interest is on the great progress in sanitation, which has almost doubled the average length of life in civilized countries.

The South American article in HARPER'S MAGAZINE for June is an account of a voyage up the Parana, from Buenos Ayres to Concepcion. This number has the first of a series of articles on London, and the second of Colonel Dodge's papers on American Riders. The other articles include a variety of interesting papers.

In the February number of SCIENTIÆ BACCALAUREUS, published by the Senior Class of the Missouri School of Mines, there are original articles on the Expansion of the Sine and Cosine; on the Prismoidal Formula; on Stadia Measuring and on the Transit of Mercury. There is also a translation of Lobatschewsky's Theory of Parallels.

In the ECLECTIC for May are found articles on Copyright, from the *Contemporary Review*; on Silver, from the *New Review*; on the Seal Islands of Bering's Sea, from *Murray's Magazine*, and a number of general interest, from the best foreign periodicals.

The Wheat Supply of Europe and America is discussed by C. Wood Davis in the ARENA for May. Dr. Blum has an article on Russia, and F. L. King an account of an Interesting Social Experiment. This includes only the papers of special interest; the general reader will find a number of others well worth careful reading.

The latest number of the NATIONAL GEOGRAPHIC MAGAZINE gives the annual reports on the Geography of the Land, by Vice-President Herbert G. Ogden, of the National Geographic Society, and on the Geography of the Air, by Vice-President A. W. Greely.

In recent numbers of HARPER'S WEEKLY there have been given two very interesting series of illustrated articles, one on the buildings for the Columbian Exhibition in Chicago, and the other on Australia. The views of the Exhibition buildings are from the Architect's plans.

The April number of the STEVENS INDICATOR gives a lecture on Drawing-Room Practice, by Professor Coleman Sellers, and a number of articles of special technical interest.

The illustrated article in the OVERLAND MONTHLY for May is a continuation of the paper on Dairying in California. The statistics given on butter and cheese-making will be a surprise to most Eastern readers. In May also is begun a series of historical papers describing, from original documents, some of the intrigues which connected California with the French occupation of Mexico.

In OUTING for May Captain King's appreciative account of the Wisconsin National Guard is concluded. The signs of approaching vacation time are visible in this number, making it at once a tempting and a trying one to the worker, whose own holiday is so short usually that he wants to use it to the best advantage.

Chief among the more serious articles in BELFORD'S MAGAZINE for May is a carefully written paper on the Future of Our Agriculture, by James K. Reeve. Mr. J. L. J. Gage discusses the question, What is Money? in another article. The number is an unusually good one, containing several bright articles of a lighter character.

A new candidate for public favor is the ENGINEERING MAGAZINE, as it is called in the May number; the first number appeared in April under the title of *Engineering*. It has 140 pages about the size of the *Popular Science Monthly*, and contains a number of articles by different authors. The May

contents include Ancient and Modern Water Wheels; Epidemics and Water Pollution; Danger Signals about the Boiler; the Rapid Transit Problem in New York; Building the Steamship in America; Tall Office Buildings; Old-Fogy Methods of Reckoning Time; Electric Railways; Railroad Building in Hawaii, and a condensed summary of engineering news.

Among the new books in preparation by John Wiley & Sons, New York, is one on CAR LUBRICATION, by W. E. Hall, of the Pennsylvania Railroad, which ought to be of interest.

## A TWELVE-WHEEL NARROW-GAUGE LOCOMOTIVE.

THE accompanying illustration, which is taken from a photograph, shows a locomotive of 3 ft. gauge, built at the Schenectady Locomotive Works, and recently completed. The engine, it will be seen, is of the twelve-wheel pattern, having eight driving-wheels 37 in. in diameter, and a four-wheel truck, the truck wheels being 22 in. in diameter. The driving-axle journals are 6 × 7 in. in size, and the truck-axle 4 × 6 in. The driving-wheel base is 10 ft. 2 in., and the total wheel base 18 ft., the rigid wheel base being 6 ft. 11 in.

The boiler of this engine is of the wagon-top pattern, and 52 in. in diameter of barrel; it is made of $\frac{7}{16}$-in. steel, the circumferential seams being double riveted and the horizontal seams quadruple riveted with a welt-strip inside. The boiler has 160 tubes of 2 in. outside diameter and 10 ft. 6 in. in length. The fire-box is 84$\frac{1}{8}$ in. in length and 24$\frac{3}{4}$ in. in width; 43$\frac{1}{8}$ in. deep in front and 40$\frac{1}{8}$ in. at the back. The water spaces around the fire-box are 4 in. wide in front and 2$\frac{1}{2}$ in. at the side and back. The crown-sheet is stayed by crown-bars in the usual manner. The grate surface is 14.4 sq. ft. The heating surface is: Fire-box, 90 sq. ft.; tubes, 872.6 sq. ft.; total, 962.6 sq. ft. The inside diameter of the stack is 14 in.

The cylinders are 16 in. in diameter and 20 in. stroke; the steam ports are 14 × 1$\frac{1}{4}$ in., and the exhaust ports 14 × 2½ in. The Richardson balanced slide valve is used, its greatest travel being 5$\frac{1}{4}$ in. The valves have $\frac{3}{4}$ in. outside lap, $\frac{1}{32}$ in. inside lap, and the lead in full stroke is $\frac{1}{16}$ in. The exhaust nozzles are double and 2$\frac{3}{4}$ in. in diameter.

The engine is expected to use a working pressure of 160 lbs., and will be employed in heavy work on a mountain grade. The total weight in working order is 72,000 lbs., of which 60,000 lbs. are carried on the driving-wheels and 12,000 lbs. on the truck.

The tender is carried on two four-wheel trucks, and weighs 22,800 lbs. empty. The tank has a water capacity of 2,100 galls., and the coal-box will contain 3½ tons of coal. The truck-wheels are 26 in. in diameter, and the truck axles have 3½ × 6 in. journals. The truck-wheels are spaced 4 ft. between centers and the total wheel base is 13 ft. 5½ in. The tender frame is of angle iron; the truck frames are of channel iron with wood bolsters, having center bearings on both trucks with additional side bearings on the back truck. The total wheel-base of engine and tender is 39 ft. 9$\frac{1}{4}$ in. and the total length of engine and tender over all is 47 ft. 8 in.

This is, we believe, the first engine of the twelve-wheel pattern ever constructed for a narrow-gauge road. The twelve-wheel pattern is growing steadily in favor, and the builders state that they have a number of engines of that type at work on mountain roads and heavy grades which are reported as giving better satisfaction in service than the ordinary consolidation pattern.

## THE MAPPING OF THE WORLD.

(From *Goldthwaite's Geographical Magazine.*)

THERE are maps without number, but many of them unfortunately are far from perfect. A great many maps are necessarily inaccurate on account of the meagre knowledge we have of large parts of the world. Thus it happens that the best maps we have of many large regions are very poor. The best maps, because the completest and most accurate, are detailed topographical survey maps. They may be called "parent maps," because it is from them that all smaller maps are made where they are accessible. These detailed topographical surveys are the result of exact trigonometrical work, and are carried on at large expense by various governments. Another class of maps which may be called topographical maps are excellent, but are the result of general and not detailed surveys. Then there are detailed geographical maps, which serve a useful purpose where better cannot be obtained. They are compiled from numerous observations and itineraries, and are fairly accurate throughout. Maps of a less degree of accuracy and value are those in which the information is only approximate or hypothetical, and which are sketched from single itineraries and reports. Our mapping of the greater part of Africa is of this nature.

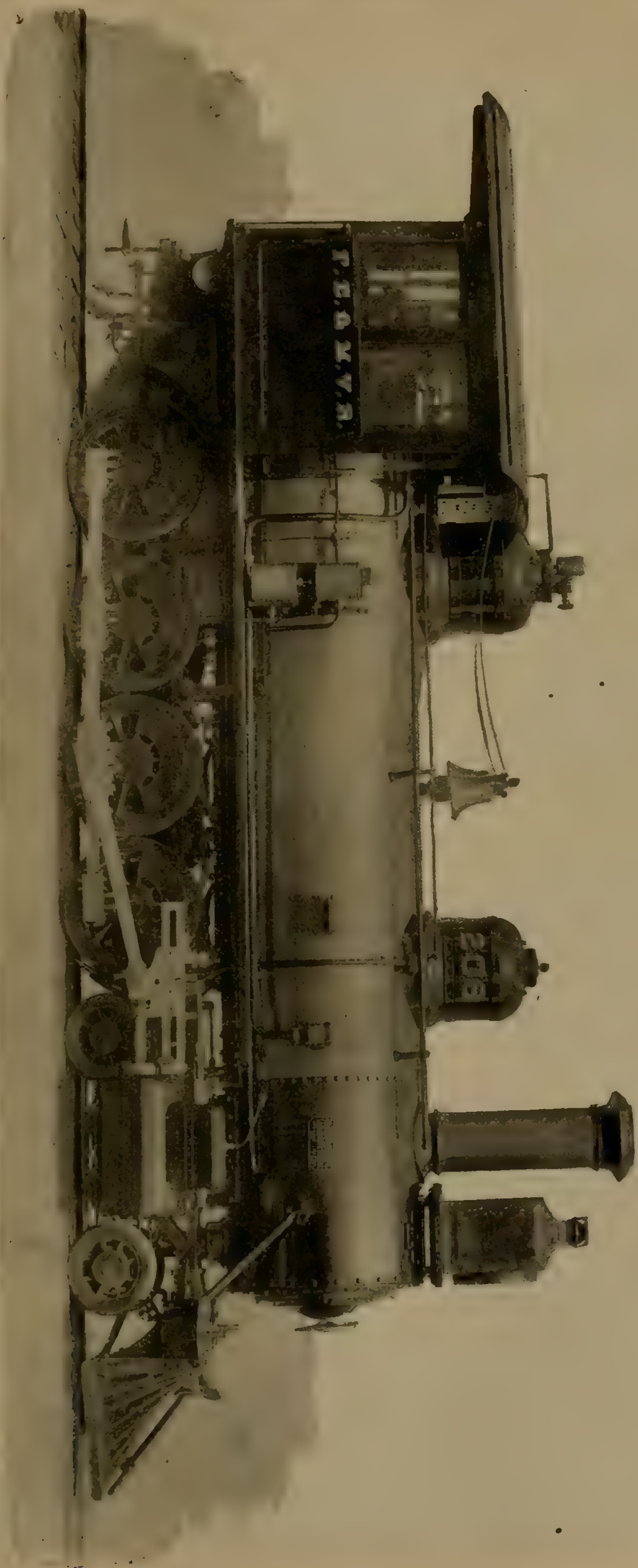
In the *Scottish Geographical Magazine* of June, last year, a very interesting map by Mr. J. G. Bartholomew was published, to show the geographical value of the best maps of all countries. This map is colored so as to show the nature of the surveys or observations, upon which our maps of various countries are based. The first thing we notice on this map is that the largest area of detailed topographical surveys is found in Europe. Almost the whole of Europe has been covered by these exact surveys. Even in the Balkan States, where the easy-going and unscientific Turk has done almost nothing to map the country that was long under his control, the work has been done for him by the enterprise of the Russians, Austrians, and Germans, who naturally have taken a very great interest in mapping this mountainous and debatable quarter of Europe. The first country on the Continent to undertake these minute surveys was France, in 1750, and the work has steadily progressed in various countries, until almost the whole of Europe has been mapped in beautiful and elaborate detail. We find, however, that in a large part of Scandinavia, Spain, and Eastern Russia, map-makers have not yet the advantage of these detailed surveys.

The next largest area of detailed topographical surveys is found in India. It may surprise some of our readers to know that India is one of the best mapped countries in the world. The great cadastral survey of India, in progress for years, was completed only recently. The sheets of this map are on a large scale, and the minute topographical features of the great peninsula are clearly shown.

Our maps of China, of the Himalayas, of Eastern Russia, of Japan, of Cape Colony in South Africa, and of Eastern Australia, are the result of general surveys, and are fairly reliable, though they do not contain the minuteness and variety of information which are results of detailed topographical surveys. The whole of Central Asia has been mapped from many observations and itineraries, and the maps are fairly reliable as far as they go. It is quite certain that our maps of Siberia are far from accurate, for enormous districts in that country have been mapped only from the reports and route surveys of single travelers.

In Africa, we find that general but not detailed surveys have been made in Algeria, along the Mediterranean and Red Sea coasts, in the Nile Valley, as far south as Khartoum, and in Cape Colony and the Boer republics. The larger part of the east and west coasts, though their outlines are without doubt depicted with a fair degree of accuracy, have not yet been adequately surveyed, and are, therefore, not presented on the maps with the greatest accuracy. The mapping of all the rest of Africa has not yet passed beyond the stages of approximately correct or merely hypothetical, and there are large areas in the Sahara, in West Africa behind the Cameroons, in the southern part of the Congo basin, and in East Africa, northeast of Victoria Nyanza, which are not yet so far known, even by native reports, as to give much satisfactory data even for hypothetical mapping.

South America has not yet accomplished anything in the way of detailed topographical surveys, though the enterprise of the Argentine Government has resulted in a general survey of the larger part of her country. It is only



TWELVE-WHEEL NARROW-GAUGE LOCOMOTIVE.

BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

along the coast line of South America that we find the maps based even upon general topographical surveys, except in Argentina and Uruguay. The larger part of Brazil, Bolivia, and the northern and Pacific Coast republics, are mapped from the observations and travels of numerous explorers. These maps are very inadequate, and the maps which some of the countries print of their territories are anything but satisfactory. Large districts, both north and south of the Amazon River, are still almost unknown, and perhaps will not be represented on our maps with even a fair degree of accuracy for many years to come.

The mapping of our own country is constantly improving, thanks to the great work which is in progress under the auspices of the general government and a number of our States. Every intelligent citizen who appreciates good maps has reason to rejoice over the work the United States Geological Survey is doing. For about 10 years past it has been pushing forward its detailed topographical surveys for the purpose of making a map of the United States. It has been able to use in this work the results of other surveys carried on in various parts of the country, and notably in the Rocky Mountain region, by Government and State organizations. The scale of this map differs in different parts of the country, being about a mile to an inch in the more thickly settled regions, two miles to an inch in less highly developed districts, and four miles to an inch in sparsely settled and desert regions. A characteristic of the sheets of this map is their simplicity and clearness. Only those cultural features which relate to the community, such as cities, roads, railways and so on, are represented. The omission of innumerable items of private culture greatly reduces the number of conventional signs, so that the map is self-explanatory. Upon this map the relief is shown by contour lines or lines of equal elevation above sea-level, thus adding a third dimension to the map. These contour lines are drawn at various intervals of height, depending upon the scale and the character of the country, the one-mile scale being commonly accompanied by a 20 ft. contour interval, the two-mile scale by contour intervals of 20 to 100 ft., and the four-mile scale by contour intervals of 200 or 250 ft. Within the past nine years an area of nearly 500,000 square miles has been surveyed, comprising 555 atlas sheets. This area is widely distributed over the country, embracing parts of nearly every State and Territory, but far the larger part of it is in the western part of the country, between the Missouri River on the north and the Colorado on the south, and including a large part of the Rocky Mountain region. Up to October 30 last, 365 sheets of this map had been engraved.

In the study of maps it is particularly annoying if coast lines are so vaguely laid down that they convey to our minds little definite information. There is no excuse now for poor mapping of our coast line. The operations of the United States Coast and Geodetic Survey have been in progress since 1836, though considerable work in the way of mapping our coast line had been done at intervals before that time. The work of the Survey, at first confined to the Atlantic and Gulf coasts, was extended to the Pacific after the acquisition of California, and has since kept pace with every extension of the territory of the United States. The objects of this work are to accurately delineate the position of the entire coast line upon the earth's surface, to map its topography, and to carry out systematic soundings of the approaches to the coast, its channels, and harbors, to collect information about tides and currents and other data of use to navigators. Since the earliest publication of the charts of the Survey, the accurate representation of all natural coast features has been recognized as essential. The charts are made in the office and are published on various scales, and since 1885 there has been an increase of over 100 per cent. in the number of charts required by the sales agents at the chief seaports. The whole number of charts distributed during the past year was 63,151. While the Coast Survey has charted the southern coast of Alaska, there is a good deal for it yet to do along the northern part of that coast line.

The Dominion of Canada has done little as yet in the way of detailed topographical surveying, though its surveys between the southerly boundary and the sixtieth parallel are sufficiently accurate for most purposes. North of the sixtieth parallel the information yet obtained about this continent is far too meagre to serve as a basis for accurate mapping. It is interesting to observe that a very considerable part of the coast line of West Greenland, from Cape Farewell to Upernavik, has been carefully surveyed, and the wonderful series of fiords penetrating far into the land may, in large part, be accurately delineated on the maps.

## LACQUER AS A PROTECTION FOR STEEL SHIPS.

Condensed from paper read before the U. S. Naval Institute by Lieutenant J. B. Murdock, and published in the *Journal* of the Institute.)

THE idea of lacquering iron and steel vessels as a protection against the action of sea-water was suggested to Mr. Hotta, a lacquer manufacturer of Tokio, by the observation that pieces of old lacquer recovered from the sea showed but little action, the lacquer being practically unattacked. As the Japanese were then purchasing iron and steel ships from abroad, and were encountering the same difficulties that were met with elsewhere in protecting the metal, experiments were made on special test-plates, which were immersed in sea-water for considerable periods, generally at the Yokosuka dockyard. The first results obtained were not fully satisfactory, but were very encouraging, and the tests were continued, varying slightly the composition of the lacquer, or adding chemicals to assist in obtaining the desired results. In June, 1886, a practical test was made by lacquering about 1,200 ft. of the bottom of the *Fuso-Kan*, using the preparation of lacquer that at that time had given the best results. The ship was docked again in September, 1887, and the condition of the lacquered portion was so satisfactory that the Admiralty gave an order to lacquer the whole bottom. In December, 1888, the ship was again docked, but the lacquer coat was found to be so good that no repairs were made. In June, 1889, the ship was again docked, the lacquer being still satisfactory. In each case anti-fouling paint was applied over the lacquer. The *Fuso* was docked once more in April, 1890, and although the lacquer covering was almost perfect it was for some unknown reason all removed by scraping, and the bottom was painted.

Many other vessels of the Japanese Navy have since been lacquered. Experimentation has been going on continually. The work is all done by Messrs. Hotta & Company, they holding a monopoly under the laws of Japan, practically the equivalent of an American patent. Not content with merely protecting the metal against corrosion, the contractors have endeavored to meet all the requirements of the case by providing an anti-fouling lacquer preparation, as well as an anti-corrosive. The use of metallic anti-fouling paints over the lacquer has been found to be injurious, the urushic acid of the lacquer sometimes attacking the metallic base of the paint, resulting in the practical destruction of the useful qualities of both. This preparation was developed experimentally, and test-plates coated with both protective and anti-fouling lacquers having given most satisfactory results immersed in sea-water at Yokosuka for eighteen months, the Japanese Admiralty ordered the lacquering of the new despatch-vessel *Yaeyama* with both kinds of lacquer. The work was performed in July, 1890, and the result will be watched with interest, as the test-plates remained perfectly clean; and if the same protection is afforded to the *Yaeyama* under the ordinary conditions of service, the anti-fouling lacquer will have vindicated its claim to be the equal if not the superior of any similar composition known.

The protective or anti-corrosive lacquer is mainly lacquer, small quantities of some inert minerals like mica or kaolin being added to increase the covering power and body of the preparation. The composition of the different coats differs somewhat, that applied directly to the skin of the ship containing the largest proportion of lacquer.

## TUNNELING PLANT ON THE TRANSANDINE RAILROAD.

(From the London *Engineering*.)

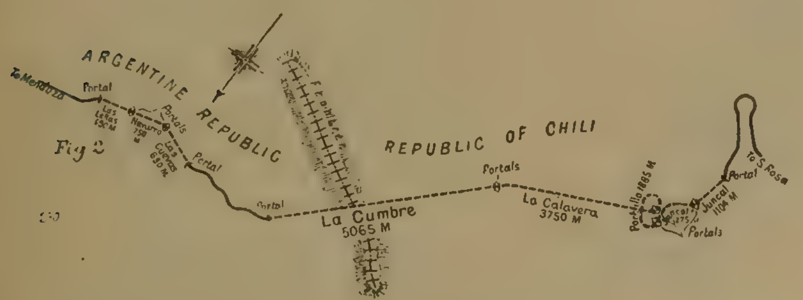
The principal difficulties found in constructing the Transandine Railroad, which is to complete the connection between the Atlantic and Pacific through the Argentine Republic and Chili, are found in tunneling and the overcoming of great differences in level in the crossing of the Andes. The total length of the new line, to which reference has already been made in our columns, from Mendoza to Santa Rosa in Chili, is 149 miles, of which 109 miles are on Argentine territory, and owned by an English company—the Buenos Ayres & Valparaiso Transandine Railroad Company, limited, while the 40 miles in Chili are owned by Clark's Transandine Railroad Company. Mendoza is 2,376 ft. and Santa Rosa 2,704 ft. above sea level, but between these points the line rises to 10,460 ft. The tunnels, which are at the point where the line attains its highest level above the sea, extend in all 15 km. (9.32 miles), and to overcome a part of the difference in level within a short distance, and at suitable working gradients, it has been found necessary to construct a spiral tunnel 6,183 ft. long. Fig. 2, appended, is a plan of the works from Juncal, in Chili, to the Quebrada Navarro in the Argentine Republic, the distance by the line being about 14 miles. In this part of the line are included all the summit tunnels, and the altitudes are indicated on the profile, fig. 1. The greatest height attained by the railroad is 3,188 m. (10,460 ft.), while the summit level is 3,800 m. (12,467 ft.) above sea level. In that distance there are, as shown, eight tunnels, the longest being the summit tunnel, having a length of 5,065 m. or 16,620 ft. The spiral tunnel is at Portillo. The radius of the curve is 200 m., equal to nearly 10 chains. Of these eight tunnels, seven are in sidelong ground admitting of openings being made, so that a greater number of working faces are obtained, thus enabling the excavation to be done in shorter time than if working only from the ends. The maximum grade is 8 per cent., and this extends for a distance of 15 km. (9.32 miles).

It may here be stated that the tunnels are for single line, the area being 18.51 sq. m. (199,244 sq. ft.), the height being 5.30 m. (17.38 ft.); the width 3.40 m. (11.15 ft.); and the radius of arch 2 m. (6.56 ft.). A section is given in fig. 3. It is in the boring of these tunnels, or rather in the means adopted, that Messrs. Clark have overcome extraordinary difficulties, and a detailed description of the plant will be interesting.

The installation may be said to be unique, as it is probably the first time that the power for compressing air for the drills has been conveyed for such a long distance by electric cables. We may refer briefly to the reasons which made such an arrangement almost imperative. In the first instance the absence of fuel on the spot and the enormous expense which would have been involved in obtaining it, precluded the use of any but natural power for driving the air compressors. Secondly, since sufficient water power could not be obtained near the faces of the tunnels, which have to be drilled by machines, it was necessary to place the turbines where the power could be obtained and to transmit it to the compressors. Upon the advice of their engineer, Mr. Alfred Schatzmann, who had had great experience on the St. Gothard and other European tunnels, Messrs. Clark adopted an electrical transmission of power. Mr. Schatzmann planned the arrangement of the installations, and fixed the power of the machines required at each.

The disposition of the various departments of the works thus becomes matter of interest, and before dealing at length with the plant itself, we shall refer more particularly to its arrangements and general efficiency. Fig. 4 shows the districts in which the various works are placed. There are three installations, one upon the Argentine and two on the Chilian side of the Andes, each being distinct in all points, except that the primary stations on the Chilian side are both located at Juncal. Each installation has a primary station where the turbines and dynamos are situated, and a secondary station with electro-motors and air compressors.

The Chilian installation consists of two primary stations under one roof at Juncal, with secondary stations at Juncalillo and Calavera, as shown on plan, fig. 4. There are separate cables for transmitting power from Juncal to



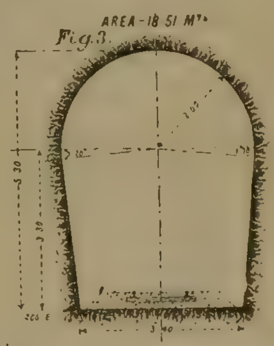
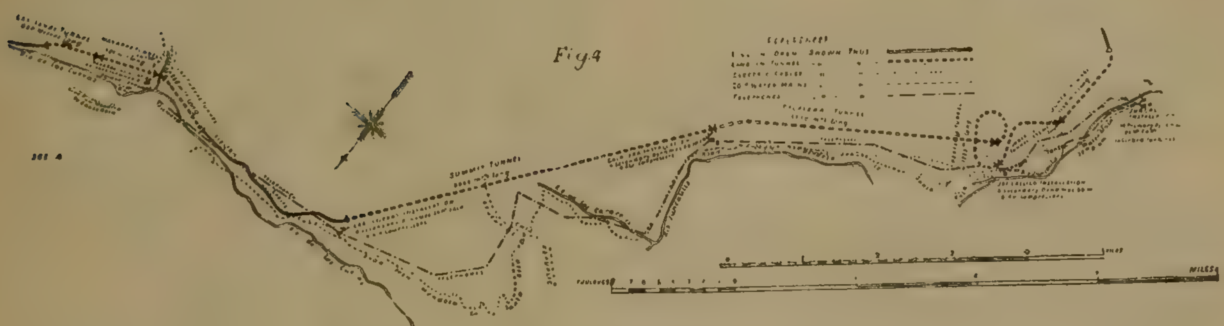



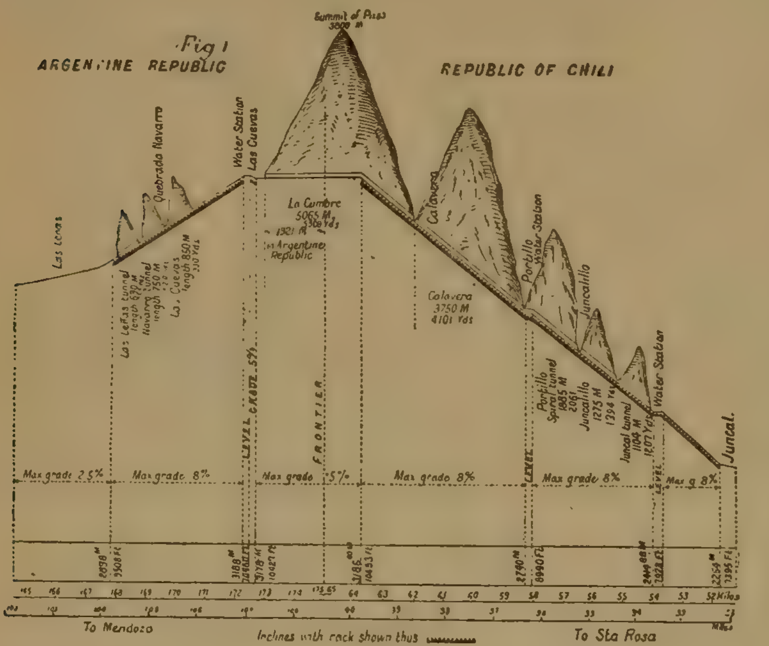

Fig. 3. Section of Tunnels on Transandine Railway.




TUNNELS ON THE TRANSANDINE RAILROAD.

Juncalillo and to Calavera. The power for driving the turbines is obtained from the Quebrada Juncalillo, the water being conveyed from the settling tanks to the turbines, a distance of 1,300 m. (about 4,260 ft.), by a double line of 20-in. diameter steel pipes.

The primary station at Juncal for this installation consists of six Girard turbines, each giving 80 H.P., effective at a speed of 700 revolutions per minute, receiving 50 litres per second (11 galls.) under a pressure of 170 m. head of water (557.8 ft.). The total power given out by the turbines is therefore 80 H.P. by 6 = 480 H.P. effective. Each 80-H.P. turbine is coupled directly on to the shaft of an 80-H.P. dynamo, consequently there will be no loss of power in transmission from the turbines to the dynamos. The dynamos, each absorbing 80 H.P., and working at 700 revolutions per minute, have an efficiency of 90 per cent., an electrical output of 400 volts and 135 amperes. They are grouped in two groups of three dynamos each, each group having a main and return transmission cable. A great advantage is gained in having two groups, as,




should accident or other cause prevent one from being worked, the whole of the tunneling would not by stopped. The cables have been calculated for 400 volts by 3 = 1,200 volts with a section of copper of 0.233 in., and having a conductivity of 98 per cent. of pure copper, the loss in the cables main and return being 8 per cent.

The secondary station at Juncalillo is 3,000 m. (about 9,843 ft.) from Juncal, the power available being 2 by 3 by 80 H.P. by .91 by .92 = 401.8 H.P. At Juncalillo the cables are attached to six electric motors, similar to those of the 80-H.P. primary dynamos, but owing to the loss in the line they will only run at 600 revolutions. The motors have a commercial efficiency of 90 per cent., and the six will give a power equal to 401.8 H.P. by .90 = 361.67 H.P. The motors running at 600 revolutions per minute drive through a shaft, running at 300 revolutions, six air compressors at a speed of 180 revolutions per minute. Assuming the loss of power due to shafting and belting at 5 per cent., the power available for driving compressors is 361.67 H.P. by .95 = 343.58 H.P. The compressors, six in number, each take in 9 cu. m. of air (317.84 cu. ft.) at six atmospheres absolute (88 lbs.). Assuming that each cubic meter of air taken in and compressed to six atmospheres requires 6.15 H.P., the powers absorbed by the compressors will be 54 by 6.15 H.P. = 332.10 H.P., which, deducted from the power available, 343.586 H.P., leaves 11.486 H.P. available for the workshops and electric light.

The installation of Juncal-Calavera is very similar to the Juncal-Juncalillo, described above. The turbines are in the same shed, and take their water from the same source. These and the dynamos are also of the same size and power; but since the distance Juncal-Calavera is 7,000 m. against 3,000 m. for Juncal-Juncalillo, the power available at Calavera for driving the compressors is proportionally less. The cables, one main and one return, have a section of copper of 0.271 in., and carry 1,600 volts (the product of four dynamos at 400 volts each, with a loss of 12 per cent. main and return). The power available, therefore, for driving the four compressors at Calavera, which are the same size as those at Juncalillo, is 4 by 80 H.P. by .91 by .88 by .90 by .95 = 219.10 H.P., the compressors requiring 6.15 by 36 = 221.4 H.P.

Turning now to the Argentine installation, the water-power upon this side is derived from the Quebrada Navarro, fig. 4, the water being conveyed to the turbines from the settling tanks, a distance of 350 m. (1,149 ft.) by a single line of 20-in. diameter steel pipes. Owing to the difficulties of transport upon the Argentine side of the mountains, 80-H.P. dynamos were found to be too heavy for transport, and machines of half the power were therefore adopted. At the primary station at Navarro, four Girard turbines similar to those at Juncal, but designed to work with a pressure of 115 m. head (377.3 ft.), with 75 litres of water per second (16.5 galls.), are used; these give each 80 H.P. effective at 700 revolutions per minute. Each turbine drives two 40-H.P. dynamos directly from its horizontal shaft, one on either side. The machines are in two groups, each of two 80-H.P. turbines with four 40-H.P. dynamos. The turbines, however, are supplied by one pipe. One group can be worked independently of the other, should any accident arise, provided it does not affect the source of water supply. The primary dynamos absorbing 40-H.P. have an efficiency of 90 per cent., with an electrical output of 250 volts and 107 amperes at 700 revolutions per minute. The cables transmitting the power have a section of 0.22 sq. in., and the loss in main and return between Navarro and Las Cuevas, a distance of 3,000 m., is 8 per cent. The 30-H.P. motors at Las Cuevas are similar to the dynamos at Navarro, and at 600 revolutions per minute have an efficiency of 89 per cent. The power therefore available for driving the compressors is 2 by 4 by 40 H.P. by .90 by .92 by .89 by .95 (allowing 5 per cent. for loss of friction in shafting and belting) = 224.74 H.P. The four compressors are of the same type as those for the Chilian installations, and calculating upon the same basis, 6.15 H.P. to compress one cubic meter of air to six atmospheres, the power required is 36 by 6.15 = 221.4 H.P.

Dealing generally with the three installations, the air is conveyed from the compressors into large steel reservoirs, and from thence to the drills in 4½-in. wrought-iron pipes. The drills are of the Ferroux type, are mounted upon carriages in groups of six, and are run forward on rails to the face. As the greater part of the tunnel is on a grade of 8 per cent., special arrangements have had to be made for clearing the débris. Where it has to be hauled forward to the open air winches are used; and where it may run out on a down grade arrangements are made whereby the full wagons draw the empty wagons to the face. The movements are controlled by special brake drums made by Messrs. Bradley & Craven.

The several stations are connected by telephone, and similar communication is established between the settling tanks and the turbine house, so that, although the works are widely separated, the same initial power, which is, by the various processes, converted into active work at the rock face, affords the means of instant and easy communication with all parts of the works. The workshops which, by the way, are built of stone found in the district, with wooden roofs sent from England, are lighted by electricity generated in a separate 10-H.P. dynamo.

The Girard turbines have been supplied by Messrs. Escher, Wyss & Company, Zurich, Switzerland; the dynamo and electrical motors by the Oerlikon Company, also

of Zurich, and the air compressors by Messrs. Burckhardt & Company, of Basle, Switzerland, firms formerly associated with somewhat similar work in connection with Swiss tunnels. The Ferroux drills were made by Messrs. Demange & Satre, Lyons, France, under the supervision of the patentee. The cables are by Messrs. Siemens.

Since the above was written, reports have been received from Buenos Ayres that the first three sections from Mendoza to Uspallata, 91 km. (56.546 miles), have been opened to traffic under the guarantee of the Government, and that the next section of 30 km. (18.641 miles) in length to Rio Blanco will soon be ready. This will bring the portion completed to 121 km. (75.187 miles), leaving 54 km. (33.5 miles) on the Argentine, and 42 km (26 miles) on the Chilian side, on which the earthworks are well advanced, to complete communication between the Atlantic and Pacific oceans; 93 per cent. of the distance from ocean to ocean can now be traversed by rail, and the works are far advanced upon the remaining 7 per cent.

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## CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

### CHEMISTRY APPLIED TO RAILROADS.
### XVII.—PAINT SPECIFICATIONS (*Continued*).

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.



(*Continued from page* 225.)

Owing to sickness in the Laboratory force during the past month, it has been impossible to make the experiments necessary to decide the points referred to in the last article in regard to how properly to design a paint, and we therefore continue in the present article the subject of paint specifications, and will also have something to say concerning the livering of paint.

The next paint specifications issued in point of time on the Pennsylvania Railroad were the specifications for *Tuscan red*. They have been in service but a short time, and therefore have not been fully tested. This material, as is well known, is used as the standard color for passenger cars on the Pennsylvania system, both east and west of Pittsburgh. The specifications are as follows:

PENNSYLVANIA RAILROAD COMPANY.

*Motive Power Department.*

*Specifications for Tuscan Red.*

Tuscan red will be bought in the paste form, and the paste should contain nothing but pigment, oil and turpentine.

The proportions of the ingredients of the paste should be, as nearly as possible, as follows:

Pigment, 75 per cent. by weight.
Oil, 9 per cent. by weight.
Turpentine, 16 per cent. by weight.

The oil must be pure raw linseed-oil, well clarified by settling and age; new process oil preferred. The turpentine must be good quality, and as free as possible from resinous matter.

The pigment desired contains no hygroscopic moisture, and has the following composition:

Sesquioxide of iron, 80 per cent. by weight.
Carbonate of lime, 5 per cent. by weight.
Organic coloring matter, 15 per cent. by weight.

Samples of dry pigment showing standard shade will be furnished, and shipments will be required to conform strictly to standard. The shade of paint being affected by the grinding, the P. R. R. standard shade is that given by the dry sample sent, mixed with the proper amount of oil and turpentine and ground, or better rubbed up in a small mortar with pestle, until the paste will pass the test for fine grinding. It is best to use fresh samples of the dry pigment for each day's testing. The comparison should always be made with the fresh material, and never with the paint after it has become dry. The comparison is easiest made by putting a small hillock of the standard paste and of that to be compared near each other on glass, and then laying another piece of glass on the two hillocks, and pressing them together until the two samples unite. The line where the two samples unite is clearly marked, if they are not the same shade.

The paste must be so finely ground that when a sample of it is thoroughly mixed, five [5] parts paste to three [3] parts of pure raw linseed-oil by weight, and a small amount of the mixture placed on a piece of dry glass, and the glass placed vertical, there will be no separation of the oil from the pigment for at least half an hour. The temperature affects this test, and it should always be made at 70° Fahrenheit. The sample under test runs down the glass in a narrow stream, when it is placed vertical, and it is sufficient if the oil and pigment do not separate for an inch down from the top of the test.

Shipments will not be accepted which

1. Contain in the paste less than 74 per cent. of pigment air dried at from 60° to 90° Fahrenheit.
2. Contain in the paste less than 8 per cent. of oil, dried at 250° Fahrenheit, or more oil than one-seventh of the weight of the pigment.
3. Contain in the paste impure or boiled linseed-oil, or more than 5 per cent. of moisture.
4. Contain in the pigment less than 75 per cent. of sesquioxide of iron, less than 2 per cent. or more than 5 per cent. of carbonate of lime, or have present any barytes, or any caustic substances, or any organic coloring matter, that has not been approved.*
5. Vary from shade.
6. Are not ground finely enough.

Theodore N. Ely,
*General Superintendent Motive Power.*

*Office of General Superintendent Motive Power, Altoona, Pa., July* 22, 1890.

It will be noted by those who are accustomed to the practices of the trade that these specifications for passenger car color made quite a radical departure from custom, since most fine colors used for passenger cars are ground in japan rather than in oil. It has been stated already in this series of articles that there was a radical distinction between carriage painting and house painting, and that in carriage painting it was essential that the color should be "flat" when dry, in order to take the varnish properly. The Tuscan red, of course, is used under varnish, and therefore it must dry "flat," and customarily japan has been used as the vehicle for the pigment. When we came to study this subject we found that the japans in the market were so varied in quality, and their examination so difficult, that we decided to make a radical step in the matter of carriage paints. As has already been said, our experiments indicate that the ratio of binding material to pigment is what determines whether a paint dries "flat" or dries with gloss, and we accordingly had our Tuscan red ground with just about enough oil, so that there will never be any difficulty about the color being "flat." This

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the Journal for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these Contributions to Practical Railroad Information of special value in indicating the true character of the materials they must use and buy.

* In view of the vast number of coal-tar products now available, whose properties are not yet definitely known, it has been deemed advisable, for the present at least, to ask those desiring to use any organic coloring matter as a constituent of Tuscan red, to submit a sample of the same, and receive approval for its use. This does not mean that each new lot of organic coloring matter obtained by the manufacturers must be approved, but that the kind of organic coloring matter used must be approved, and no change must be made in the organic coloring matter that has been once approved, unless authority to do so is given by this Company.

amount, however, is so small that it is impossible to get the pigment through the mill with the oil alone, and accordingly turpentine is added in order to make the material grind. This use of oil in place of japan requires some special arrangements in the mixing of the paint, and these arrangements are covered by the circular given below. As said above, very few difficulties have thus far arisen with regard to this paint, although many of the painters are so accustomed to the use of material ground in japan that they still prefer it. Of course they use the material according to specifications.

In a large system like the Pennsylvania Railroad, where shops are supplied from different portions of the country and by different manufacturers, it was believed that it would be practically impossible to get uniformity of shade if the shipments were ground in japan. Moreover, for the same shop supplied by two different makers the successive shipments differ a little in proportions and kind of japan, and consequently with each new shipment a new method of manipulation must be learned in the shop. These difficulties have been largely obviated, it is believed, by the standard specifications, and now a shipment of Tuscan red anywhere on the whole system is, within reasonable limits, the same thing.

The same remarks made use of in the last article, in speaking of *freight car color*, apply equally well to the oil used in grinding Tuscan red—namely, new process oil is preferred, because it is more apt to be free from mucilaginous matter. Thus far no difficulties have arisen over the quality of turpentine used, and although the specifications require turpentine as free as possible from resinous matter, there are some unworked-out problems in regard to the influence of rosin or pitch in turpentine which we are hardly able at present to give any definite information upon. Some painters prefer what is known as rather "fat" turpentine, which means turpentine which has oxidized somewhat, or which contains some pitchy matter. In order to get the conditions as uniform as possible with successive shipments, we have tried to have this material excluded.

It will be observed that in this pigment quite a contrary view is taken than was maintained in regard to freight car color—namely, as much as possible of the pigment is coloring matter, and as little as possible is inert material. This is believed to be entirely philosophic, and to have good reasoning back of it. In freight car color the inert material is used in order to increase the volume of pigment in the paint, and thus add to the durability, and also because inert material is usually cheaper and more durable than the specific colors; so enough coloring matter is used to give the desired shade, and the rest of the pigment is made of inert material. Not so, however, with *passenger car color*. Here the color is the only thing wanted, since we do not at all rely on the Tuscan red to protect the surface. The protection is obtained from the varnish, which is put on over the color, and, as is well known by every practical railroad man, when the varnish has gone the color is of little account. In brief, in passenger car painting, as in carriage painting in general, the color desired is put on to the prepared surface and is covered and protected from the weather by a special liquid called varnish, so that the necessity and desirability of inert material does not exist. Accordingly we make our passenger car color as high in coloring matter as possible. The material is usually applied in very dilute form, giving very thin coats, and these coats follow one another rapidly. The object of this is to get the surface well covered with color, and at the same time not have it too long in drying, it being found that three thin coats dry much more rapidly than two thick coats.

We have some experiments with passenger car color low in coloring matter. These show that three thin coats of such paint very frequently give a streaked job, owing to the scarcity of the coloring matter, and to such an extent is this the case that many of the Tuscan reds of the market, which are quite largely diluted with inert material, cannot be used successfully with the practice which prevails in the Pennsylvania Railroad Shops—namely, of using three thin coats of color.

The special shade of Tuscan red is usually obtained by taking Indian red and brightening it with some organic coloring matter. The organic coloring matter most frequently used is what is known in the market as *chatemuc*, or *wood lake*, which, as we understand it, is an extract of dye woods of various kinds precipitated with alumina or tin salt, the tin salt giving the preferable pigment. Indian red, as is well known, is largely sesquioxide of iron, and it is only necessary in making the P. R. R. Tuscan Red to take a good rich Indian red and add the proper amount and kind of wood lake. Other coloring matters are, however, approved for use, notably the *alizarin lake*, which may be quite easily obtained in the market. *Carmine lake* and *madder lake* are both moderately expensive, and apparently the amount required is so great of these materials as to make their use almost prohibitory in view of the price. We are, of course, constantly experimenting with new coloring matters, and stand ready at any time to approve any new coloring matter which seems to have a fair amount of durability in it. Meanwhile, we are obtaining such material as is needed by the use of chatemuc and alizarin lakes.

The same remarks made use of in the last article on freight car color, in regard to shade, apply equally to Tuscan red. Practically, we do not find absolute uniformity in successive shipments from the same makers, nor in shipments of the same material from different makers. The shades, however, are sufficiently near to identity, so that two cars painted with different shipments from the same manufacturer, or with shipments from different makers, standing side by side would hardly have difference enough in shade to excite attention. Until our specifications were issued this was certainly not true, as cars from different shops supplied by different makers frequently showed wide differences in color.

The test for fine grinding of Tuscan red is the same as that made use of in freight car color, except the proportions are different. The limits toward the bottom of the specifications which decide for what causes shipments will be rejected are perhaps clear and easily understood. No upper limit of amount of pigment is given, as, if the limit of oil is followed, it is immaterial to us how much pigment is used, and the necessities of grinding are usually what limit the amount of pigment.

The limits of oil in the specifications are from 8 to 12½ per cent., and thus far we have had no occasion to complain of shipments varying outside these limits. The turpentine, of course, fills out the 100 per cent. after the proportions of pigment and oil are specified, and we put no limit on this, allowing each maker to use whatever he might find necessary in order to get the pigment through the mill, except that the pigment and oil limits must be filled. The reason why we prefer the raw oil instead of boiled oil will be given when we come to finish up the discussion of the question, "How to Design a Paint," since it properly comes in that article, under the heading, "What Liquid Shall be Used?"

The reason for the use of carbonate of lime in Tuscan red is exactly the same as with freight car color—namely, much of the Indian red is or may be made by the ignition of sulphate of iron, and it is possible not all the acid is driven off, and our experience, as has been previously stated, indicates that a little carbonate of lime facilitates drying. The kind of organic coloring matter has already been discussed, and we will only add here that there are such a large number of reds made with some of the coal-tar products as a basis which are fugitive, that we have felt compelled to protect ourselves against these by the requirement that we must be furnished with a sample, and have a chance to test any new organic coloring matter that it is proposed to use in this paint.

The instructions for mixing Tuscan red are as follows:

PENNSYLVANIA RAILROAD COMPANY.

*Motive Power Department.*

*No. 84.—Instructions in Regard to Mixing Tuscan Red for Passenger Car Color. Superseding Circular issued July* 23, 1890.

The Tuscan red heretofore used has been almost universally ground in japan. This practice will be abandoned, for all Tuscan red purchased in accordance with the P. R. R. Standard

Specifications, and the Tuscan red furnished will be ground instead in oil and turpentine. This change in the composition of the paste will necessitate some changes in the method of mixing. The following formula is found to work satisfactorily at the Altoona Car Shops:

| | |
|---|---|
| Tuscan Red (P. R. R. Specifications).... | 10 lbs. |
| Coach Makers' Japan.................. | 2½ pints. |
| Rubbing Varnish...................... | 1½ " |
| Spirits Turpentine............... .... | 5 " |

There is some difference in the japans in the market, and it is also probable different localities require different proportions in order to secure satisfactory drying, and proper results when the varnish is applied. Each shop is therefore allowed a certain amount of discretion in proportions according to the japan used and the locality in which it is situated.

In matching old and faded color, it is of course expected the standard Tuscan red will be toned with other materials to secure the shade. Two parts burnt and one part raw Sienna, with a trace of raw umber, when mixed with an equal weight of P. R. R. Standard Tuscan Red are found to approximate the color of Standard Tuscan Red that has been exposed to the weather for six to eight months.

THEODORE N. ELY,
*General Superintendent Motive Power.*

*Office of General Superintendent Motive Power, Altoona, Pa., April* 23, 1891.

It will be observed that these instructions have just been issued. The first edition, which was issued when the Tuscan red specifications were printed some nine months ago, were practically the same, except that no varnish was used, but it was found that some of the shipments of Tuscan red did not have quite binding material enough on the old formula, and accordingly a new formula was given. As is indicated in the instructions, considerable latitude is allowed to the different shops in this mixing, depending on the locality and on the different kinds of japan used. Recently our attention has been called to another peculiarity—namely, that a formula which works nicely with shipments from one manufacturer may not work with shipments from another manufacturer, although both shipments pass the requirements of our specifications. We are not yet fully prepared to explain this anomaly, but we are inclined to think it has something to do with the kind of organic coloring matter used, and also possibly that the fineness of the pigment exerts an important influence. All our experiments indicate that the finer the pigment the more binding material is required, and although our specifications give a test for fine grinding, they do not say that shipments shall not be finer than this test will admit of, so that if shipments are received from two different manufacturers, and one of them just passes test for fine grinding and the other is a great deal finer, it will undoubtedly be found in the use of these materials that the finer will require more binding material.

The chemical operations involved in the analysis of Tuscan red present no special points of difficulty. The oil and pigment are separated by means of gasoline, the pigment being washed with more gasoline two or three times by decantation. The gasoline is evaporated, leaving the oil for subsequent test. We use Maumene's and other tests for determining the purity of the oil. Of course, the weights of the separated oil and pigment are taken. The amount of oxide of iron in the pigment is determined in the volumetric way by means of permanganate of potash, or standard bichromate of potash. The details are entirely familiar to every chemist, and do not need special remark. The carbonate of lime is determined by taking a definite weight of separated pigment and determining carbonic acid by loss, calculating this as carbonate of lime. The method is not entirely free from objection, but will give results with careful manipulation within a small fraction of error. The amount of water present in Tuscan red is determined by taking a weighed portion of the original paste and adding to it a weighed amount of dehydrated sulphate of copper. Another portion, same amount of the paste is weighed out, and no sulphate of copper added. Both the portions are then treated with gasoline, and the oil separated completely. The material remaining behind in the flask is then dried by aspirating dry air through the flasks, and both flasks with their contents are then weighed. The water, if any is present, passes off during the aspiration through the flask which contains no sulphate of copper, while the water, if any is present in the flask containing the anhydrous sulphate of copper, is retained by the sulphate of copper, and increases the weight. The increase in weight, of course, shows the amount of water. This method gives fairly satisfactory results, and is perhaps accurate to 0.10 or 0.20 per cent. The method for distinguishing the various organic coloring matters present in the Tuscan red may be found described somewhat at length in special treatises on this subject. We are using partially methods which we ourselves have devised, and partially well-known methods given in the treatises. These methods are somewhat lengthy of description, and would perhaps hardly be worth the space they would occupy in this series.

## XVIII.—THE LIVERING OF PAINT.

FROM time immemorial all painters have occasionally been annoyed by finding a bucket of paint which had been mixed up ready for spreading over night, so thick the next morning that it could not be used. The material in the bucket could be cut out in lumps and looked like liver, and consequently this behavior has received the name of "livering." The peculiarity is too well known to require further description. The causes which have been assigned for this remarkable behavior have been very numerous, and its erratic and puzzling occurrences have led many to regard it as one of the unsolved and unsolvable mysteries of painting.

Studies on this subject in the Pennsylvania Railroad Laboratory, some two or three years ago, indicated that this peculiarity was related in some way to the water chemically combined with the sulphate of lime in the pigment, and in the specifications issued March 25, 1887, an attempt was made to overcome the difficulty by having the pigment dried at 250° Fahrenheit. This drying at 250° Fahrenheit removed a portion of the water chemically combined with the sulphate of lime in the pigment, and proved an effectual remedy for livering, provided the paint mixed with large amounts of strong japan was not allowed to stand over 24 to 36 hours. But with paints mixed ready for use of course much longer time is necessary between the mixing and the spreading, and on attempting to make some ready mixed paint the old difficulty appeared. This has led to renewed study of the subject, which study indicated as follows: Gypsum, or hydrated sulphate of lime, contains two molecules of water. When this material is heated to the proper temperature more or less of this water is driven off. In this condition the sulphate of lime is known as plaster of Paris, which is one of the well-known commercial forms of the article, and the form in which some of it finds its way into paint. Still further, Venetian red made by modern methods contains a large amount of sulphate of lime, which, since it has been retorted, may have only a small portion of the water necessary to form gypsum or fully hydrated sulphate of lime. If now, as is well known, either dry plaster of Paris, or plaster of Paris mixed with iron oxide or other pigment, or dry Venetian red not fully hybrated, or the same Venetian red mixed with other pigments, or a mixture of dry plaster of Paris, iron oxide and Venetian red, such as is frequently used in making the Pennsylvania Railroad shade of freight car color, are treated with water, the sulphate of lime takes up water and sets, the hardness of the setting being proportional to the amount of not fully hydrated sulphate of lime present before treatment with water. This has been proved by repeated experiments, and it seems safe to conclude in general that if a pigment containing sulphate of lime not fully hydrated can get water from any source there will always be a tendency for it to assume a more or less solid form.

Turning now to such pigment as is above described mixed with oil and japan, Müldér has suggested that during the drying of linseed-oil water is formed and given off —a fact which helps to explain the slow drying of paint in damp weather. The atmosphere, being nearly saturated with moisture in damp weather, does not as readily take up the water formed during the drying of the oil, and the getting rid of the water formed being an essential to drying,

the operation is retarded. Furthermore, it is possible the same thing is true with regard to linseed-oil containing japan—viz., water is formed during the drying, and some believe that when large amounts of strong japan are mixed with linseed-oil water is immediately formed throughout the mass by reaction between the japan and oil. If now there is pigment present containing more or less sulphate of lime not fully hydrated, this sulphate of lime takes up the water as it is gradually formed, with the consequent tendency to set. The presence of the oil and japan of course prevents the material from setting to a hard stony mass, as when only pigment and water are present, but, as is well known, livered paint is not a hard mass, the liver being more or less hard, apparently in proportion to the amount of sulphate of lime which gets water present in the paint. According to this explanation, therefore, livering is the setting of the sulphate of lime in the pigment as far as is possible for it to do so under the circumstances, the water necessary being in most cases furnished by the reaction between the oil and japan in the mixed paint. Of course a wet bucket, or water accidentally introduced, will produce the same result. If the above reasoning is correct there will be no livering if the sulphate of lime is in such a condition that it does not take up water, or if the amount of water furnished is too small to cause the material to set. This latter alternative explains why pigment dried at 250° Fahrenheit does not liver in 24 to 36 hours—viz., not enough water is formed during that time by the reaction between the oil and japan to cause the change to take place. But, as already stated, drying the pigment does not, in general, prevent the difficulty for a longer time than this.

Two other methods of securing the desired end present themselves—viz. : (1) It is claimed that if sulphate of lime is heated to or above a red heat, it will not again take up water. To do this, however, is both expensive and uncertain, as it is well known that there are certain substances which might occur as impurities in the pigment that would make sulphate of lime capable of enduring red heat without losing its power of taking up water and setting. (2) It is obvious, provided the explanations above given are correct, that if the sulphate of lime in a pigment has taken up all the water it requires before the pigment is ground with oil there will be no further trouble from livering when the paint is mixed ready for use, and this view of the case is confirmed by many experiments. The hydration of the pigment being simple and inexpensive, we have accordingly decided to ask in our specifications for a pigment in which the sulphate of lime is fully hydrated.

As the result of considerable experimentation, a successful method of introducing the water has been found, which is as follows : Weigh or measure into the chaser the amount of oil required for the batch of paint that is to be made. Add to this the amount of water required to fully hydrate the pigment, and start the chaser in operation. An emulsion is formed between the water and oil. Now add the carbonate of lime required for the batch of paint, keeping the chaser in operation all the time, and then add in any convenient way—probably best by the shovelfull—the balance of the pigment. By this method the water and the carbonate of lime are uniformly mixed throughout the whole mass of paint, and no hard lumps of pigment are formed, to be subsequently reduced to a fine state of division by the grinding. The easiest method of determining how much water is required to fully hydrate the pigment is to weigh out one-half ounce of it, and put it in any convenient vessel in a thin layer. Then sprinkle it thoroughly with water, and allow it to stand over night, until all the water evaporates. The increase in weight will show approximately how much water is required. It will be observed that our specifications for freight car color allow for an excess of 2 per cent. of water over what is necessary to fully hydrate the pigment, and the specifications for Tuscan red allow an excess of 5 per cent. These limits, of course, must not be exceeded, but it is not objectionable to have a small amount of water present in the paste when shipped.

The explanation given above of the philosophy of livering of paint has been criticised somewhat by parties to whom the information was communicated, but no other information has been suggested which would account for the facts. The main criticism was that other pigments than those containing sulphate of lime would occasionally liver, notably white zinc, and possibly one or two other substances. We made experiments with white zinc, and found that when dry, white zinc was mixed with water and the water allowed to evaporate, the white zinc caked and became very hard. It would seem, therefore, that the presence of water would explain the livering of white zinc in the same way that it explains the livering where sulphate of lime is present. We are quite well aware that red lead sets very hard in a bucket when mixed with oil, and this may be regarded as a species of livering. We do not, however, regard this as being explained in the same way.

The philosophy of the setting of red lead is, we think, due to chemical reaction between the oil and the lead, although we have not made experiments enough to positively say this is the case. With red lead two chemical reactions are possible—namely, a combination between the litharge of the red lead and the glycerine of the oil, and also a combination between the litharge and the fat acids of the oil, resulting in the formation of lead soap. It is well known that glycerine and red lead make a very good hard cement, and also it is well known that lead soap is in itself quite a firm substance, so that it is possible both these reactions may take place, and if so they would explain the setting of red lead. It is possible, still further, that the livering of white zinc may be due or assisted by chemical reaction between the oil and the zinc, since we find by actual experiment that white zinc combines with the free fat acid in linseed-oil quite readily, even at ordinary temperatures, forming a zinc soap which would have a tendency to stiffen the mixed paint.

In the next article we hope to discuss the deferred question.

(TO BE CONTINUED.)

COAST DEFENSE SHIP "MONTEREY," FOR THE UNITED STATES NAVY.

## THE UNITED STATES NAVY.

THE coast defense ship *Monterey* was successfully launched from the yard of the Union Iron Works, in San Francisco, on April 28. The President of the United States was present at the launch. This ship has been heretofore described, but, as some changes have been made since the plans were first published, and as a matter of convenience, a condensed description is given herewith.

The general dimensions are: Length over all, 261 ft.; length on load water-line, 256 ft.; extreme breadth, 59 ft.; mean draft, 14 ft. 6 in.; displacement, 4,000 tons. The ship is of the monitor type, with very low freeboard, but differs from the monitors in having a central barbette.

The main battery will consist of two 12-in. breech-loading rifles mounted in the turret at the forward end of the barbette, and protected by 13-in. steel armor, and two 10-in. breech-loading rifles mounted in the turret at the after end of the barbette, protected by 11½-in. steel armor. The secondary battery includes six 6 pdr. and two 1-pdr. rapid-fire guns, and four 37-mm. Hotchkiss revolving cannon.

The hull of the ship is very strongly constructed throughout, and the bow is ram-shaped, and especially strengthened for ramming. The hull is protected by a belt of steel armor extending the entire length of the vessel, varying from 13 in. amidships to 8 in. and 6 in. at the ends. She has an armored deck 3 in. thick covering the engines and other machinery. The conning-tower, barbette and other parts are protected by heavy armor. The military mast has two tops, one carrying two revolving cannon and the other the electric search-light.

The engines are expected to work up to 5,400 H.P., and to give the ship an extreme speed of 16 knots an hour. There are twin screws, each driven by a separate engine, and the boilers and engines are carefully protected.

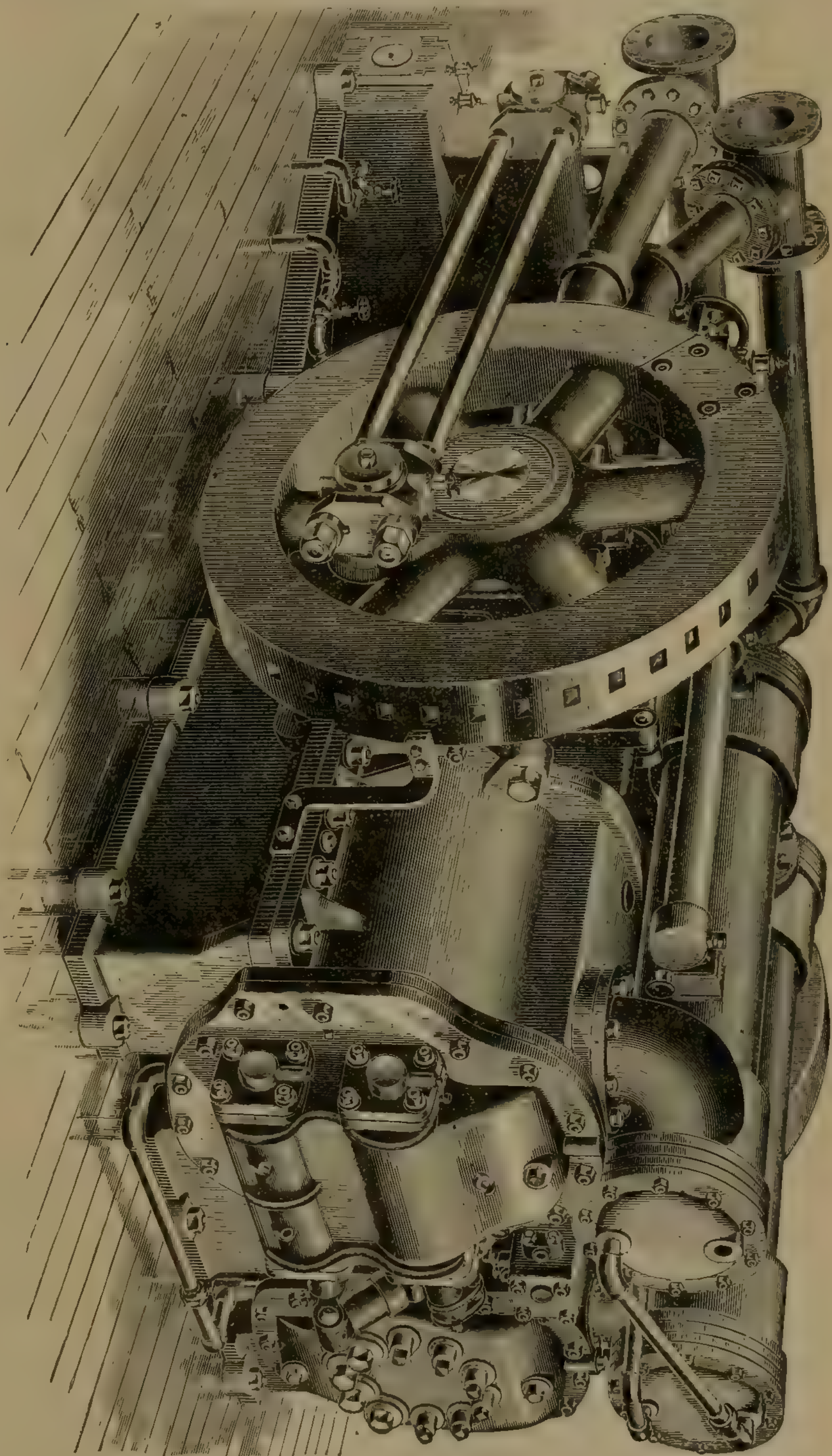
### THE AIR COMPRESSORS FOR THE "TERROR."

The accompanying illustration shows an air compressor of very compact type built for the monitor *Terror* by the Norwalk Iron Works Company, at South Norwalk, Conn. There are two of these compressors, each of the same size, and they are now completed and being put into the ship.

Each compressor is of 250 H.P. The intake air cylinder is 28 in. in diameter, and the compressing cylinder 17½ in. The ordinary pressure will be from 100 to 150 lbs., but there is a supplemental cylinder by which the pressure can be carried to 2,000 lbs. if needed for torpedo or other service. The machines being for ship service, are necessarily made in compact form, and are only 14 ft. 4 in. long and 8 ft. 4 in. wide.

The *Terror* has four 10-in. breech-loading rifled guns, and the entire service of loading and elevating the guns, turning the turrets, taking up the recoil and bringing the guns again into battery will be done by compressed air. The advocates of this method claim that by reason of its great elasticity the air will do this work with less strain on the vessel than when hydraulic power is used.

The compressed air will also be used to refrigerate a cold storage room, to run the steering apparatus, hoist ammunition, and for other minor purposes.



THE AIR COMPRESSORS FOR THE "TERROR."

### GUNS AND ARMOR.

The Ordnance Bureau of the Navy Department has been making some tests of one of the new 10-in. rifled guns built for the double-turret monitor *Miantonomoh*. The tests were made at the new proving-ground at Indian Head, on the Potomac. In the heaviest charge this gun used 239 lbs. of powder, giving a pressure of 15 tons, while the projectile had a muzzle velocity of 2,116 ft. per second. This is the best result obtained so far with this class of guns. The fourth 10-in. gun for the

same ship is about finished at the Washington Navy Yard, and will shortly be taken to the proving-ground for test.

The Board appointed by the Secretary of the Navy some time ago to consider the best methods of fitting armor to ships has made an elaborate report accompanied by a number of drawings. This board consisted of Naval Constructors Phillip Hichborn and J. J. Woodward, and Professor R. R. Alger. Among the points considered in the report are the design of the bolts intended to secure the armor, for which it is proposed to use a thread of a new pattern. Other points are, the best method of handling the plates by floating derricks in the case of ships in the water, or by stationary cranes or derricks for it in dock, and portable cranes for handling plates in places difficult to reach by the larger cranes. Plans for holding the plates are also suggested. For drilling the hulls through the back and into the plates the Board recommends the use of portable drills run by electric motors, which can be carried anywhere.

## STOPPING A COFFER-DAM LEAK.

A LETTER from Colonel O. M. Poe, U. S. Engineers, to the Cleveland *Marine Review*. gives an interesting account of the boring and ramming process by which the recent leak in the coffer-dam at the Sault Ste. Marie Canal was found and stopped. The letter says:

The coffer-dam referred to consists of a clay wall having a minimum thickness of 8 ft. This clay wall is supported on each side by a line of crib-work filled with stone, and therefore pervious to water. A portion of the dam extends from the west end of the north wall of the present lock up-stream along the middle of the canal for about 580 ft., and then turns squarely into the north bank of the canal. The leak occurred about 100 ft. east of where this turn is made, and was situated entirely beneath the crib-work, the bottom of which, at the site of the leak, was 22½ ft. below the surface of the water in the canal. The crib-work was not disturbed. At the deepest point the leak was at least four feet below the bottom of the crib, therefore 26½ ft. below the level of the water in the canal, or about 9 ft. *lower than the level of the water in the river below the lock.*

The rush of water underneath the dam was so great that bales of hay and gunny-sacks filled with clay thrown into the cavity were carried through. By driving sheet-piling on the down-stream side of the space from which the clay wall had been carried away, a sufficient obstacle was established to prevent hay in bales and clay in sacks from being washed through, and after some 2,000 sacks of clay had been thrown in it became possible to fill the gap with loose clay. But the leak still remained too large for the pumps to handle, and to further reduce it, as well as to get something into place more substantial than the sheet-piling which had been driven at first, timbers 12 in. square, sharpened to a chisel edge at the lower end, and shod with iron to the extent of the ability of the entire blacksmith force at the Sault to manufacture, were driven with a 1,900-lbs. ram between the sheet-piling and the crib-work, until they could be driven no further, when it was assumed that they were in contact with the rock formation, and a note made of the depth to which they had gone. The clay wall was then loaded with heavy piles of stone to compress it, and the result was a reduction of the leak to such a degree as to bring it easily within the control of the pumps, and nineteen days after the break the lock-pit was again empty of water. The volume of water in the pit was about 45,000,000 gallons, and this, in addition to the leakage, was handled by the pumps in less than seven days.

Although the pumping capacity available was sufficient to easily keep the lock-pit empty, it was still very desirable that the leak should be entirely stopped, and it was believed that this could be done very soon after its exact location was ascertained. To find the crevice in the rock through which the water was passing, an iron rod was driven down through the clay wall, in front of and close to the timbers already referred to, until it would go no further. The depth to which it penetrated was compared with the depth to which the timber had been driven, and the proper notes were made concerning any effect upon the muddiness of the leak. The rod was then withdrawn, moved laterally, an average distance of 8 in., and again driven to the rock. This operation was continued until at one place the rod went 2½ ft. deeper than at a distance of 8 in. on either side of it. Here then was the crevice sought, and the next thing to be done was to fill it with clay or other water-tight material. It was nearly 30 ft. below the top of the clay wall, and more than 26 ft. below the level of the water in the canal. It was not practicable to excavate down to it, and no other mode than that known as "stock-ramming" seemed available by which to put the clay "where it would do the most good."

Stock-ramming consists simply in driving a tube of requisite diameter to such depth that its lower end will be at the point where it is desired to deposit the clay or other impervious material, and then forcing such material through it in such quantity as may be necessary. In this particular case the tube used is an iron pipe. An iron rod is used as a piston, and this piston is driven down by a pile-driver, the clay with which the pipe had been filled being forced out at the lower end. When the piston has reached the lower end of the pipe it is withdrawn, the pipe is again charged with clay, and the operation of forcing it out is repeated. This is continued until the clay rammed in forces upward the whole column of clay above it, when, as is obvious, the operation can be carried no further.

The whole operation is a simple one, and resembles nothing else so much as stuffing sausages, which, I dare say, first suggested its use many years ago.

The leak had been stopped before the ice had been gotten out of the canal. As soon as the canal could be cleared of ice, the movable dam was double-battened, the valves of the lock were opened, and for the first time since the completion of the present lock the water was drawn off from that portion of the canal below the movable dam. More than half the bottom was laid bare. The withdrawal of the water from the canal of course reduced the upward pressure upon the clay wall of the coffer-dam, and the mass of clay, 30 ft. high, compressed under its own weight as much as 18 in. in the case of the new clay put in at the site of the leak.

The successful manner in which this leak was dealt with greatly increases our confidence in our ability to control any which may occur in future, but it does not remove our anxiety. That will abide with us until we no longer need the dam. But we regard the dam as now better than ever before, and the experience gained will enable us, in case of any future leak, to apply the most efficient remedial measures in the shortest possible time.

It was never supposed that a work like this could be carried on, under all the surrounding conditions, without great difficulty and many annoyances. But for the necessity of providing for navigation while the new work is in progress, the work would be simple enough. All the trouble we have thus far encountered has arisen from this necessity.

## THE DEVELOPMENT OF THE COMPOUND SYSTEM IN LOCOMOTIVES.

BY M. A. MALLET.

(Paper read before the Société des Ingenieurs Civils, Paris; translated from the French by Frederick Hobart.)

(*Concluded from page* 206.)

### OBJECTIONS TO THE COMPOUND LOCOMOTIVE.

WE propose now to examine in detail the different objections which have been and still are presented against the use of double expansion in locomotives. We cannot do better than to take for a guide in this task the paper of M. Polonceau, not that we place that eminent engineer among the opponents of the new locomotive, since he has always repelled such a charge, but because we find in his work collected and presented under a form readily understood the different arguments by which it has been sought

to prove that the advantages claimed for the application of double expansion on railroads were either not obtained, or if they were, were counterbalanced by more or less serious inconveniences. We will examine one by one the objections which are successively presented.

The first is the favorite argument of the opponents of the compound locomotive, and is an objection to the principle. They say "the service of locomotives is entirely different from that of stationary and marine engines. The work of a locomotive varies continually; but the compound engine is especially economical for a constant work, and seems to become less economical for any work other than that for which it has been adapted; in other words, what is good for the one may perhaps not be good for the other."

It is difficult to find the reason of the prejudice which many people have that the expansion in successive cylinders is not adapted to any notable variation of power. It is really only a prejudice, and both theory and practice agree in refuting this hypothesis when presented under a general form. We see, however, this objection always brought forward before all the others.

Let us then examine it with some care.

We will note first that the case of locomotives and that of stationary engines under the conditions of hard and variable work are entirely different. In the stationary engine the speed of travel must remain constant whatever the load, and it is then the work produced by a variable effort at constant speed which varies. In the locomotive, on the other hand, the speed changes continually, and in an opposite direction from the effort of traction, which is changed from one instant to the other according to the profile of the road. The work then does not show great variation; it is the effort of traction. If, moreover, it is said that the resistance of a train increases with the speed, chiefly on account of the resistance of the air, and that this speed can be considered within certain limits as inversely proportioned to the grade, we find that in most cases and for lines of moderate grade, the effort of traction does not vary within such wide limits as one would at first suppose.

Is it true that for locomotives the expansion of steam in two successive cylinders will not permit as great a variation of the total effort upon the pistons as if the expansion took place in a single cylinder?

In a locomotive with double expansion the maximum introduction of steam can be carried without difficulty to 85 per cent. of the stroke, and we need not reduce it below 25 per cent. because it is useless and we desire to obtain the most favorable conditions for distribution.

The limits of expansion will then be, for a ratio of volumes equal to two between the cylinders, from 2.35 to 8. If we neglect the counter-pressure and take the initial pressure equal to 1 we will obtain average pressures representing the total effort of .0788 and .0380 respectively; that is, 2.07 and 1. The ratio of these two figures represents the variation of effort which can be given theoretically by the variation of the admission. It is well understood here that the question is on this point and not at all on the reduction which can be obtained by the partial closing of the throttle valve.

For the ordinary locomotive we take as the extreme limits for the introduction of steam 70 and 15 per cent. The first is greater than that which is employed at any time except in starting and the second does not give good conditions of distribution, at least with the motions in actual use. The corresponding degrees of expansion are then 1.42 and 6.60, and if we carry this out, as above, we obtain average efforts of 0.949 and 0.435, giving a ratio of 2.18 and 1.

The pretended superiority of the ordinary machine is then expressed by the ratio 2.18 to 2.07, or 5 per cent. of increase in the possible variation of effort; that is in quantity, for as to the quality of work we see that this variation is only obtained on the condition of admitting as a maximum in the ordinary machine a degree of expansion less than $1\frac{1}{2}$, which is positively a ridiculous idea for cylinders receiving steam from the boiler at a pressure of 140 to 170 lbs. The preceding statement is approximate, but we do not believe that the opponents of the compound system can meet it by one more precise.

In a practical point of view the economical results given by the compound locomotive, which seem very difficult to contest in presence of a mass of facts, appear to give a final blow to the error which we are combating, since these machines unite the conditions, which are claimed to be incompatible, of small expense and of variable work. This blow was not the first, and this incompatibility so often alleged had already received other hard blows from experience with machines other than those of railroads. No one would pretend, for example, that hoisting engines, or engines used for running the dynamos for electric lighting are machines with constant work. Nevertheless, the compound system is applied to advantage to such engines, and with very favorable results as to economy. It is hardly necessary to bring instances in proof of this, since it would be difficult to choose one from the great number of examples.

It is not at all certain whether it is well to meet the entire variation in the effort of traction in a locomotive by varying the admission to the cylinder only, and that we should not use throttling to a certain extent. This is a question which is far from being solved. We believe that the reduction of pressure by the throttle valve gives better results on a compound locomotive, which has already a maximum of expansion below which the engineer cannot descend, than upon an ordinary locomotive, where he can by this means do away with expansion almost entirely.

Continuing our arguments we can hardly treat seriously the opinion that: "In order to make just comparisons, we should not take only trials made with locomotives of different systems, but those made exactly under the same conditions. In this manner only, economical results found are real."

This is precisely what many conscientious experimenters have done, among whose number it will be sufficient to cite De Borodine, Urquhart, and many others, who are certainly interested in eliminating from their comparisons every foreign element which can vitiate their conclusions; and it is because the conditions recited have been absolutely filled that the economical results obtained must be received as real, and that we must attach the greatest importance to the conclusions drawn by distinguished engineers after prolonged experiment made upon a considerable scale, and also sanctioned by applications every day more extended.

Again, it is objected that if we change a locomotive by increasing its adhesive weight, which was before too low in relation to its heating surface, we will evidently have economical results from the compound, simply from increasing this weight, and that such results prove absolutely nothing.

Such a case has been presented under exceptional circumstances; but it seems difficult to admit that a change of 2,000 or 2,200 lbs. in weight in certain engines, which did not increase sensibly the adhesive weight, can explain a saving in fuel of 15 to 20 per cent. Even if this should be so, would not this be simply a cheap method of adding to the power of ordinary locomotives, and open a wide field of economy which we must have been very wrong to neglect until now?

The observation which we have just made answers the objection made that "to obtain a real economy it would be necessary to take account of the water saved, of the water used, to consider the cost of fuel and water for difficult loads and speeds, and to be careful to use fuel of the same quality, to have engineers of equal ability, and to take account of the influence of time, etc."

It is sufficient to refer to the memoir of M. de Borodine to show with what scrupulous care these conditions have been observed.

In a general way, when one or several compound engines are put in service with others, from which they differ only because one of their cylinders has from 6 to 8 in. more diameter and does the same service, one would suppose that the economy obtained is not the result of chance or of entirely foreign circumstance, especially if the comparison has extended over a long period.

Another objection is that "new machines, when they are new, made the subject of particular care by their inventors, with carefully chosen engineer and fireman,

always show a considerable economy, and when they are left to themselves, with a more or less capable engineer, as with ordinary engines, they often do not show more than 50 per cent. of the economy found upon a special trial."

This observation is a very just one; but we do not see how it can be applied outside of certain cases to compound locomotives rather than to others, such as those having improved valve motions, etc. We could, on the other hand, reverse the proposition and say that when a machine gives good results when beyond all control or interference of its inventor or manufacturer, and managed by the ordinary engineers of the line, who have no reason whatever to be interested in it, and indeed are apt to look with more or less doubt at new things; when the service is prolonged beyond the period during which the engine can be considered new, or when perhaps the engine, before being altered, had already seen 15 or 20 years of service; when all these conditions present themselves, we certainly ought to have a double faith in the value of the results entertained. This is a case which has been found presented in my own experience, for example, in Russia, in Switzerland, on the departmental railroads, and elsewhere.

M. Polonceau does not believe that the economy obtained by the compound system can be over 5 to 8 per cent., but he gives no reasons which have led him to this conclusion in presence of the 15 to 20 per cent. saving obtained by experimenters who have merited entire confidence. It is clear that if the compound engine has been used under conditions exceptionally favorable with relation to the others, we must be very cautious in deducing general conclusions from the results obtained, but in practice it is just the contrary, because it is presented as we have shown. So far as concerns the influence of the engineer and fireman, it certainly exists; but when the compound engines are managed successively by several engineers taken at random, and the economy in fuel is kept up; when the engines run over different lines, sometimes at a distance from each other, and having different profiles, although owned by the same company, and still the same results are obtained; when the engineers have to run alternately a compound and an ordinary locomotive and always obtain a considerable saving with the first; finally when the least consumption of the compound, as officially reported, shows a notable reduction of 10 to 15 per cent., for example, of the amount of fuel allowed to these engines in comparison with ordinary engines running in the same service, the influence of the engineer seems to have practically disappeared in determining the result.

M. Rodieux, Chief of Motive Power of the Jura-Simplon Railroad, said recently that in his opinion, and according to the facts which he observed in service, the use of compound working annulled in great part the influence of the engineer on the consumption of fuel, the compound always having a considerable minimum of expansion, 2.30, for instance, instead of 1.40, as we have previously shown, without the engineer being able to interfere. His opinion is of great importance. I hope that these facts, proofs of which I have in my possession, will be sufficient to convince some of my opponents.

Besides these objections, it is claimed that certain advantages attributed to the compound have not been really obtained. This point can be discussed very briefly, and really seems to rest in part on a misapprehension. The ease of starting, the better exhaust, and the stability of the compound are questioned, and it is denied that the compound is in better condition than the ordinary engine in these respects. I do not believe that any one has ever claimed this, at least under such form. In the beginning the enemies of the double-expansion locomotive based their objections upon these three points. It could not start; its exhaust was not free, and it was defective in stability. Experience has proved that all these amount to nothing. Now the ground has been shifted, and the superiority of the compound engine on these three points is contested; that is to say, its enemies admit that it is not inferior. For my part, I am not disposed to ask more.

There is, however, something to be added for starting. In reality the double-expansion engine is under superior conditions on this point, because with well-proportioned ordinary engines, under tolerable conditions of steam pressure, we should never run at more than 50 per cent. admission. It is only the necessity of being able to start in any position which obliges us to carry the maximum admission to 70 per cent., and to give consequently greater variation to the distribution than would be necessary for the regular running of the machine. In the compound, on the other hand, the high introductions can be used in ordinary running, and put us under very favorable conditions for starting. It is of course understood that the engine has proper starting apparatus.

As to the question of stability, some distinction is to be made. It is necessary to know what compound engines are spoken of. A point in which the superiority of a compound engine is incontestable is that for the same degree of expansion of the steam the moments of rotation around the axle show less variation, and that in consequence of other things being equal, we can employ a higher co-efficient of adhesion. It is this superiority and that which results from the lower value of the maximum strain in relation to the average strain undergone by the parts of the machine which are important. Thus one part in transmission of a steam engine, as a piston-rod or connecting-rod, taken upon an ordinary engine, will transmit an average strain much more considerable on a compound engine because that average strain can be brought nearer to the maximum strain, taken as the same in both cases, which the piece has to transmit. This is one of the considerations which led to the use of the Wolff type on the Northern Railroad of France. Now neither steam jackets nor superheating nor improved systems of distribution could give such advantages.

It is not to be denied that in the double-expansion locomotive, having for the same total expansion longer admissions in each cylinder and a wider opening of ports, there is less wire-drawing of steam than in the ordinary engine. It is useless to say that this inconvenience in an ordinary locomotive can be remedied by special systems of distribution, because innumerable solutions of this problem have been proposed during the last 15 years without any practical result. If the compound locomotive is a complication, would not the use of special valve motions, such as the Corliss, be a still greater one?

Really, as one of our Russian colleagues has expressed it, "The only complication involved in the compound locomotive is the increase in the diameter of one of the pistons, and the addition of a starting apparatus which is of very slight importance. Certainly the addition of complex and delicate apparatus to the ordinary locomotive, requiring an increase in expense of lubrication and maintenance, without counting the chance of breakage, even should these devices be completely successful, will only realize partially the object which is obtained in a much simpler way by the compound engine."

The changes made in stationary engines are very significant. The improved valve motions—Corliss, Sulzer, Wheelock, etc.—were at first adapted to single-cylinder engines, but to-day their inventors apply them on compound and triple-expansion engines, as was shown in a number of instances at the Exposition in 1889.

The diminution of interior condensation is one of the causes of the economy obtained by dividing the expansion between two successive cylinders. This is a well-established fact. We do not dispute that the exchange of heat between the walls of the cylinder and the steam may be modified in importance by the rapidity of the working of the machine, but to conclude, from that fact, that in a locomotive the influence of the compound in point of view of condensation can be taken into account is altogether another thing.

As long ago as 1850 Mr. D. K. Clarke found in locomotives, at the end of the expansion, an increase in the quantity of steam present in the cylinder, which could only be attributed to the revaporization of condensed water during the period of admission. These well-known experiments are the first by which this fact has been established on railroads, and they were further confirmed in France by the experiments made on the Orleans Railroad about 1852. The experiments made in 1867 by Herr Bauschinger on the locomotives of the Barbarian State Railroad will show the importance of this phenomenon. He found there an

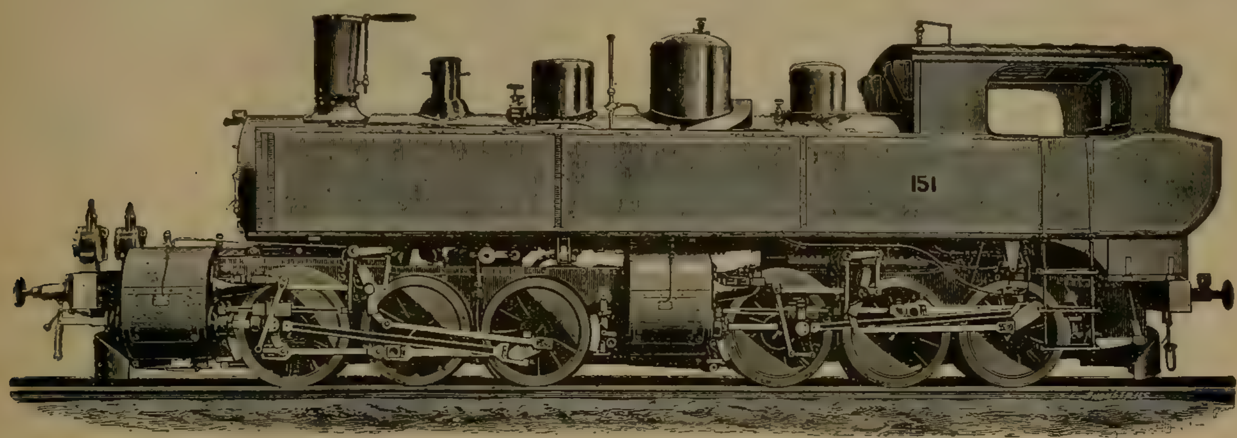
increase exceeding 100 per cent. in certain cases, and which only in exceptional cases descends below 20 per cent. between the quantity of steam present in the cylinder at the commencement and at the end of the expansion in locomotives in which the number of revolutions per minute varied during the trials from 80 to 180. Now, at this last speed, which can be considered as normal, the increase in the weight of steam during the period of expansion is indicated at 20 per cent., and that for a very partial cut-off, 37 per cent. At 157 revolutions, with the admission reduced to 23 per cent., the increase in weight of steam rose to 67 per cent.

Analysis of diagrams taken during the experiments of M. de Borodine, give the quantity of water revaporized during expansion, varying from 8 to 19 per cent. of the weight of the dry steam contained in the cylinder at the time of the cut-off.

We may here recall that the compound engine is used in a number of cases as a rapid-running engine, such as in electric light motors, torpedo boat engines, and others for the deficiency of which we have spoken. It must be understood that we must still seek by other means to prevent the exterior cooling of the cylinders, and of all the parts through which the steam circulates ; but this is an independent matter, and cannot be cited as an objection to the use of the compound, since it applies to all machines.

We now arrive at a point where we must meet this claim : "The two-cylinder compound cannot have cylinders of sufficient volume, therefore it is not economical ; it is, therefore, necessary to use more than two cylinders, and then the economy of fuel will be counterbalanced by the increase in expense of construction, of lubrication, and of maintenance."

We have already sufficiently proved that the fears relative to the insufficiency of the dimensions of the cylinders of the two-cylinder compound are exaggerated, and that this type suffices for almost all our present needs. The 750 engines of this model in actual service offer a sufficient proof. If we are obliged to recur to the use of more than two cylinders, it would be to obtain some advantage beyond the economy in fuel, such as the increase of power, flexibility, or, in a word, some new advantage which would compensate for the additional charges due to the complication of parts. We do not believe that any one would use four cylinders simply for the pleasure of making them when two would be sufficient. The increase of power, for example, should bring about, outside of the economy of fuel, a reduction in the expenses of traction—that is, train expenses ; it would justify a reasonable increase in the cost of lubrication and maintenance. This is really the way in which the question should be considered. As a matter of fact, we can cite the result obtained with a compound engine on the Jura-Simplon Railroad, which, in a year's service, running about 22,000 miles, consumed 3.8 per cent. less of lubricating oil than the average of other freight engines in the same service ; the engines being the same, with the exception of the compounding of the cylinders. It is well to note here that experience so far obtained in America has supported my conclusions. The two-cylinder compound in that country has shown considerable economy ; and while the Webb engine has been less successful on the Pennsylvania Railroad, the Baldwin four-cylinder type promises to do much better. I may also note that the Master Mechanics' Association appointed last year a Committee on Compound Locomotives, which presented a very interesting report.



ARTICULATED COMPOUND LOCOMOTIVE FOR THE GOTHARD RAILROAD.

where the piston speed is greater than that of locomotives. The remarkable experiments of Mr. Willans show that at 400 revolutions a minute this action of the walls of the cylinder is not annulled, and the experimenter concluded that with a non-condensing engine working at this speed it is worth while to employ the compound, even with boiler pressures not over 80 lbs.

We might again cite a very curious experiment in which the influence of interior condensation has been placed directly in evidence in a way which gives room for no doubt. In a trial made by M. Pulin, on the Northern Railroad of France, of a compound engine with equal cylinders, proposed by myself in 1875—a plan proposed and taken up since with some modifications of detail by M. de Landsee—it was found that this engine, run by the same engineer and doing identically the same work, used notably less fuel while running with admission of steam in only one of the two equal cylinders, and the passage of that steam into the other cylinder, than with a direct admission of the steam into the two cylinders. This diminution of consumption, obtained with a considerably less expansion, could only be attributed to the diminution of condensation brought about by the reduction of the fall of temperature in the cylinders, the total surface of which in contact with the steam was the same in both cases. Can the less effect of interior condensation be compensated by the increase of cooling surface due to the presence of a large cylinder ? I do not think so. In the case of the two-cylinder compound engine, the total area of the surface is about 25 per cent. greater than in the ordinary engines. The loss of heat by radiation, with cylinders sufficiently protected, is estimated at 5 per cent. On this basis the compound would have an inferiority of 1.25 per cent. as compared with the ordinary engine. If this loss is appreciable—and I do not believe that it is—this would prove that compound working gives still greater advantage than it has been credited with, since it will have to compensate

Among other advantages, we may mention not only the reduction in the weight of the fuel burned, but the fact that a reduction may be made in the heating surface of the boiler, or if this is kept at the same size, there may be an increase in power or a reduction in the work imposed upon the steam generator. In France the economy in fuel has been found of importance, even upon the Northern Railroad, the French line which obtains its coal at the lowest price.

Other objections made to the compound are noted, but they are really only a repetition of those which have

already been considered under different forms, and to repeat the arguments by which they are refuted seems hardly necessary here in this memoir, which has already extended itself to considerable length. In a word, it may be said that the compound locomotive is passing through the stage of argument and debate, beyond which the compound for stationary and marine work has already gone, and it is to be hoped that the result with the locomotive will be the same. In fact, in the case of the marine engine, the compound or double-expansion engine has itself given place to triple-expansion, and the quadruple expansion is already coming into use.

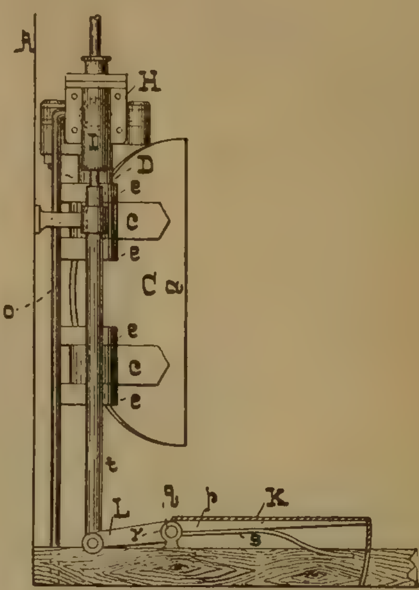
This experience of the past may be instructive for the adversaries of the compound locomotives. We may find further instruction in the testimony of many distinguished engineers, whose convictions are based on their own practice, and who cannot be suspected of being subject to improper influences. M. de Borodine, whose name I have frequently quoted, said, last year, in the International Railroad Congress, that on the South-west Russian lines, "We have a dozen compound locomotives in service for several years, and they have given such satisfactory results that all those which we build in the future will be of this system. I believe that the next Exposition in Paris will show more compound engines, and that no company will exhibit any ordinary locomotive."

Is not such a clear declaration, based on prolonged personal experience, worth more than volumes of argument? We could add nothing to it which would not weaken it.

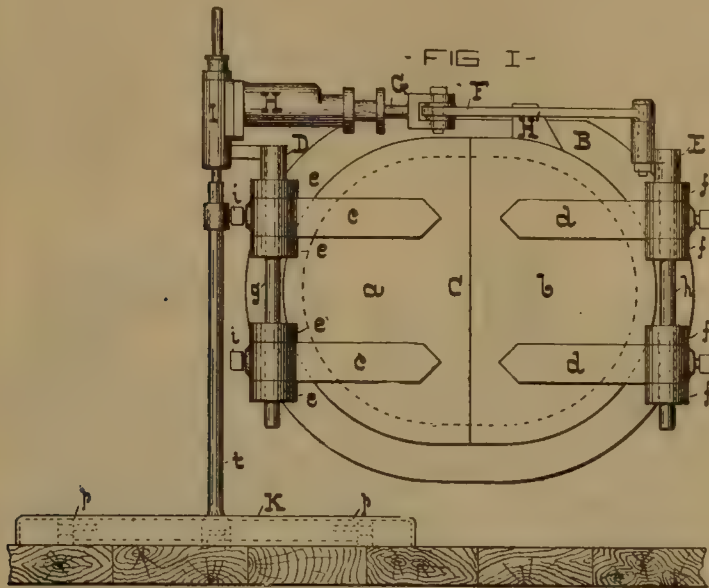
## FIRE-BOX DOOR-OPENER.

THE inconvenience of opening and closing the doors of locomotive fire-boxes every time a shovelful of coal must be put on the grate every fireman knows, and all persons who understand the principles of combustion and have had opportunities of observing must be convinced that

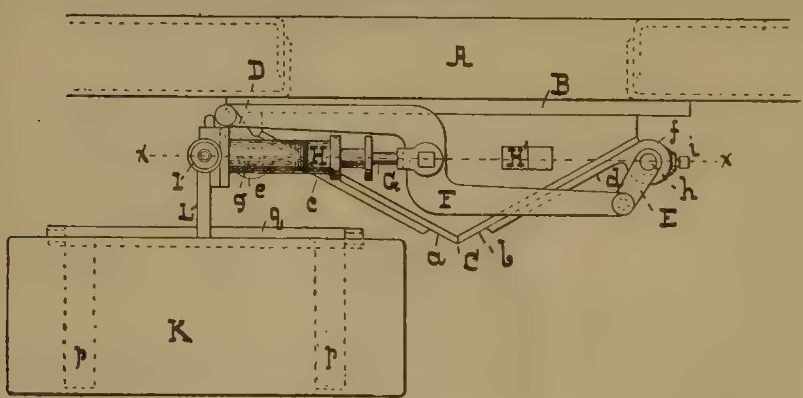
-FIG II-



-FIG I-



-FIG III-



FORNEY'S FIRE-BOX DOOR-OPENER.

the frequent opening of the door and the admission of large quantities of cold air into the furnace must lessen the efficiency of the boiler to a very great degree. When a locomotive is working hard it is safe to say that the furnace door is open from a third to a half of the time. If the door was kept open *all* the time it would be impossible to make a sufficient quantity of steam for even ordinary work. Having it open a half or a third of the time must reduce the quantity of steam generated at least a half or a third as much as keeping it open all the time, and there can be no doubt that the steam-producing capacity of the boiler would be very materially increased if the time that the door must be kept open was diminished.

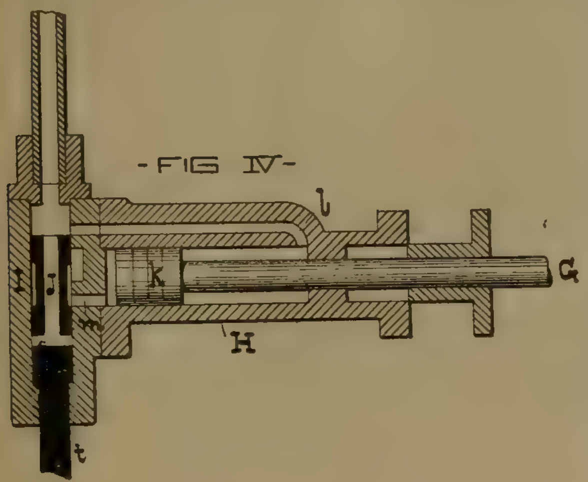
The invention illustrated herewith is intended to facilitate the opening and closing of the door, do it quicker, and with more ease and less inconvenience to the fireman, so that it will be open for much shorter periods, and thus admit smaller quantities of cold air to the fire-box.

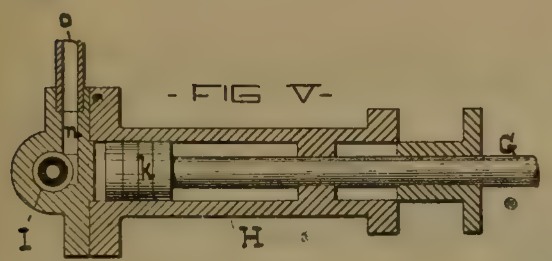
Figs. I and II are, respectively, a front and a side view of a locomotive-furnace door provided with the improvements. Fig. III is a plan of fig. I, showing a part of the front of the boiler. Figs. IV and V are respectively a vertical sec-

tion and a sectional plan of certain parts of the invention on an enlarged scale.

In the drawings *A* is a part of the boiler, and *B* the door-frame secured to the boiler in the usual manner.

*a* and *b* are the furnace-doors, formed in two parts or sections, which are hinged to the frame *B*. The hinges consist of the brackets *c* and *d*, attached, respectively, to the sections *a* and *b* of the door, the lugs *e* and *f*, attached to the frame *B*, and the bolts *g* and *h*. These bolts pass




loosely through the lugs *e* and *f*, and are fastened to the brackets, preferably, by means of set-screws *i*.

*D* and *E* are arms or cranks rigidly attached to the upper ends of the bolts *g* and *h*, and they project in opposite directions from a dotted line, *x x*, in fig. III—which extends through the center of the bolts *g* and *h*—in order that when the cranks are moved in the same direction the bolts *g* and *h* are swung around in opposite directions, and the sections *a* and *b* of the door *C* are jointly opened or closed. The arms *D* and *E* are coupled together by means of an offset-bar, *F*, to the middle of which is pivoted the piston-rod *G* of a steam-cylinder, *H*, hereinafter described.

As the ends of the coupling-bar *F* move in arcs of circles curved in opposite directions, the path of the middle point of the bar is a straight line, and with the cranks forms a "parallel motion," therefore the piston-rod *G* can be connected directly to the bar at this point without the intervention of guides or connecting-rods to maintain the rectilineal movement of the end of the rod.

*H'* is a stop to arrest the movement of the piston when the doors are opened wide enough. The cylinder is supported in any suitable manner, but preferably from the front of the boiler, and it is provided with a piston, *k*, figs. IV and V, which is at the inner end of the piston-rod *G*.

*I* is the steam-valve chest at the rear end of the cylinder *H*, connected with the interior of the said cylinder by means of the front and rear steam-ports, *l* and *m*. The exhaust-port is denoted by *n*, and the exhaust-pipe leading therefrom by *o*.

*J* is the steam-valve, which is shown as of the piston form, adapted to slide within the valve-chest *I*. This valve operates to control the admission of steam to the cylinder in substantially the same manner as that of a slide-valve engine, and it is moved from a hinged foot-plate, *K*, figs. I–III, by mechanism substantially as follows: The foot-plate is secured to two arms, *p p*, on a vibratory shaft, *q*, supported in bearings *r* on the foot-board and yieldingly supported by means of a spring, *s*, underneath. *L* is a third arm, also attached to the shaft *q*, which projects in an opposite direction to the ones *p*. To the arm *L* is connected a rod, *t*, the upper end of which is just below the bottom of the valve-chest. The valve has a projection which extends downward and outside of the valve-chest, as shown at *t*, fig. IV, and bears on the upper end of the rod *t*.

When the fireman desires to open the furnace-door, he depresses the plate *K* with his foot, when the steam-valve *I* is raised through the medium of the arms *p p* and *L* and the rod *t*, before described, and steam is admitted to the port *m*, and thence to the rear end of the cylinder *H*. The piston is thus driven forward, and its movement transmitted to the two sections of the furnace-door through the medium of the piston-rod *G*, offset-rod *F*, arms *D* and *E*, and the bolts *g* and *h*, to which the said arms are rigidly attached. In the depression of the foot-plate the supporting spring [*s* is forced down ;] consequently its resilient action as the foot is removed raises the plate *K* and arms *p p* and depresses the end of the arm *L* and rod *t*. The pressure of the steam above the valve then forces it down into the position shown in fig. IV, which permits the steam below the piston to be exhausted and live steam to enter the cylinder in front, which forces the piston back into the position shown in fig. IV, thus closing the doors.

This device is the invention and has been patented by Mr. M. N. Forney, whose address is at the office of the RAILROAD AND ENGINEERING JOURNAL, No. 47 Cedar Street, New York.

## THE SUBMARINE MINE AND TORPEDO IN HARBOR DEFENSE.

BY FIRST LIEUTENANT JOSEPH M. CALIFF, THIRD U. S. ARTILLERY.



(*Concluded from page* 219.)

### XIV.—CONTROLLABLE TORPEDOES.

THESE, being always under control and intended to be operated from shore stations, are particularly well adapted for harbor defense. This class embraces the *spar*, the *towing*, as well as all the controllable locomotive torpedoes. The latter, and by far the most important type, includes all those operated by power developed at some point exterior to themselves, which power is transmitted to the torpedo either by electrical or mechanical means, or where the motive power is self-contained and the control alone exercised from the shore. The *Sims-Edison*, the *Patrick*, the *Brennan*, and the *Victoria* are the best-known examples of locomotive torpedoes.

*Spar torpedoes.* As the pioneer of all offensive devices of its kind, the spar torpedo has a record for actual work unequalled by any other similar weapon. As an English writer says (Sleeman), "all the ships that have so far been sunk or injured by torpedoes have met their fate at the hands of the spar torpedo, with the exception of one extremely doubtful case of a vessel sunk by a Whitehead in the Russo-Turkish war of 1877." It should be said, however, that none of the locomotive type have as yet had an opportunity to test their efficiency in actual warfare.

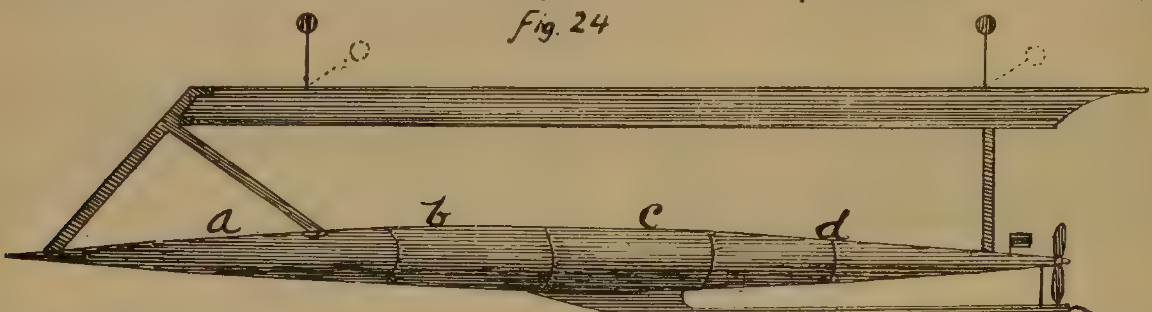
In the many new devices being brought forward, its value is likely to be lost sight of. Its extremely limited range, which is the length of the spar to which it is attached, is in a measure compensated for by the accuracy and certainty with which its blow can be delivered. As a weapon it requires no detailed description. From the simple case of explosive fastened to the end of a spar, which explodes upon contact with the side of an enemy's ship, to some of the later and more elaborate inventions, the principle is the same. Although its employment is always considered more than usually hazardous, yet as the

equipment of small, swift steam-launches and in the hands of a daring commander, ready to take advantage of smoke or fog or accident to swoop down upon an incautious adversary, it is believed to have a field to itself in the problem of harbor defense.

The *Towing torpedo*, whose name indicates its mode of action, was at one time largely experimented with and adopted to some extent in the French and other services, but with the introduction of improved forms of controllable torpedoes it has generally been discarded.

*Locomotive torpedoes.* The *Sims-Edison* torpedo is an American invention, propelled, controlled and exploded by means of an electrical current supplied through proper cables from a dynamo on shore. Fig. 24 represents the general features of this weapon. It consists of two parts—the torpedo proper and a float, which maintains it at a uniform depth. The former is a copper cylinder with conical ends, 20 ft. × 30 in., rigidly connected with its float, of the same material, by steel rods. The forward rod slants to the rear and upward from the nose of the torpedo, so that it will dive under any ordinary obstruction in its path. Projecting above the float are two steel rods, each carrying a ball for purposes of steering. These rods are hinged to the skin of the float, and bend backward when an obstruction is encountered and the torpedo dives, resuming their upright position when the obstruction is passed. The float is boat-shaped, is water-tight, and filled with cotton or other buoyant material. The torpedo body is divided into four sections, as shown. The front compartment, *a*, is for the explosive charge. Within the second, *b*, is coiled a compound cable, having a small insulated core in the center for the steering current, and an annular conductor for the motor current. The third compartment, *c*, contains an Edison motor, which can, at full speed, develop something over 30 H.P. of energy for propulsion. The after compartment, *d*, contains the steering gear. The direction is given through the agency of an electro-magnet and a polarized relay, actuated by the steering current through the central conductor of the cable. By these means the balanced rudder on top of the after cone can be thrown to one side or the other at will. It has a total weight of about 4,000 lbs.

Fig. 24




The range of this torpedo is limited only by the length of cable that can be carried and the distance the steering balls can be seen. Two sizes have been proposed, carrying cable for one and two miles. A charge of from 200 to 500 lbs. of high explosive, according to the size, is provided. This is exploded electrically at the will of the operator. This torpedo has been carefully experimented with at the Willett's Point Torpedo School, and has been found to be under thorough control. A speed of 22 miles per hour has been obtained.

The *Patrick* torpedo resembles the Sims-Edison just described in that it consists of a torpedo proper and a float, which maintains it at a submergence of about 3 ft. It is driven by a carbonic acid gas engine, and has attained a speed of about 20 miles per hour, and has a range of one mile. The charge is 200 lbs. of dynamite, which may be fired electrically at will or upon contact. It is started, stopped and guided upon its course by means of a two-wire electric cable, in connection with 100 cells bichromate battery. The wire is paid out from the shore station as the torpedo advances. It has received a favorable report from a board of naval officers, after an extended series of experiments.

The *Brennan* torpedo has been adopted in England. In it the motive power is external to the weapon, and is communicated mechanically to the torpedo. Upon two reels within the torpedo, which are geared to the propeller-shafts, is wound a quantity of fine steel wire equal in length to four times the distance to be run. The ends of these wires are led out through the top of the shell, through leaders at the tail and thence over drums at the winding station on shore. By winding up the wires on the drums the reels are made to revolve, and thus actuate the propeller. By operating the drums at different speed motion is communicated to the rudder and the direction given. Hydrostatic pressure, transmitted to diving rudders, controls the submergence. It has about the same speed and range as the Patrick.

The *Victoria* torpedo is a Whitehead in all essential particulars, with the additional device for starting, stopping and firing it at will by means of an electrical current supplied from the shore station through an insulated cable coiled within a compartment of the torpedo, and paid out as it advances.

For the practical operation of controllable torpedoes an observing station, where a clear and uninterrupted view of the harbor can be had, is necessary. Here, in any system of electrically controlled torpedoes, are the keys, switch-boards, etc., and the officer charged with their manipulation. This station must rely for safety either upon being wholly inconspicuous or upon protective works. The torpedoes themselves can be moored in any concealed position, while the dynamo, engine, etc., must, of course, be perfectly protected by bomb-proofs, or otherwise.

Many other types of both classes of torpedoes, other than those mentioned, have been experimented with with greater or less success; these latter, however, are considered the most promising. Abroad, the Whitehead type has been universally adopted, and is being manufactured in large numbers both in England and upon the Continent. Of the controllable class, the English have purchased the Brennan, and have already begun its manufacture and distribution. The French have experimented with the Patrick, but other than these, it is not known that any other power contemplates the introduction of controllable torpedoes. On this side of the Atlantic contract has been made for a considerable number of Howell torpedoes, but it is not known that any have been delivered, nor have we a single controllable torpedo other than one or two purchased for experiment.

The chief drawback to any fish or missile torpedo must always be a want of accuracy. Traversing a medium that is never wholly at rest; influenced, even when its initial direction is true, by waves, tides and currents; often launched upon its course from a moving against another moving object, it can easily be seen how uncertain are likely to be the results obtained. The controllable torpedo, on the other hand, can be driven against its object, when atmospheric conditions are favorable, with great accuracy, carrying at the same time considerably greater charges of explosive. It should not be forgotten, however, that while a Whitehead or a Howell costs about $2,000 each, a Sims-Edison or a Patrick will cost just about ten times this amount; nor that a more or less complicated shore plant is needed for the service of the latter, while the former can be discharged without preparation of any kind.

XV.—GENERAL CONSIDERATIONS.

Whatever may be the character of the mine and torpedo defense of a harbor, it must not be forgotten that, no matter how elaborate and efficient these may be, they are only auxiliary. The main reliance must always be upon batteries and guns, nor will the presence of these auxiliaries justify any material reduction in the artillery armament. In the absence of batteries any arrangement of mines can be readily neutralized or destroyed; nor would it be possible to operate, against an enemy's fleet, any system of torpedoes—whether with launches, torpedo-boats or controllable torpedoes, except under the fire and protection of powerful batteries.

In none except the largest harbors would a resort be had to a complete mine and torpedo defense. In such a case this defense would have to be divided between the army and the navy contingent. In addition to the gun defense, all fixed mines and controllable torpedoes would naturally come under the control of the military commander; while the use of harbor defense craft of all kinds, torpedo-boats and launches fall into the hands of the naval commander. The character of the harbor will determine the extent to which mines and torpedoes can be effectively employed. The water approaches of New York, for instance, lend themselves readily to an elaborate scheme of mine defense, while in the harbor of San Francisco the depth of water and the swiftness of the currents makes their employment extremely difficult, if not impracticable.

Speaking of the defense of New York, Colonel Bucknell says that it is a case where there is a strong front door but a weak back entrance—the back entrance being through Long Island Sound, and the front door by way of the Narrows. The eastern entrance to the Sound is through the Race, between Gardiner's and Gull Island, which is some 4½ miles in width, and is at present wholly unprotected by fortifications, and is a water-way where mines could not well be employed. Where the Sound narrows at Throgg's Neck (Fort Schuyler) both the artillery and mine defense become powerful. It is, however, only eight miles from upper New York, and vessels lying in this neighborhood could reach this point and the outlying suburbs of Brooklyn. To the south, with the proposed works on Coney Island, Sandy Hook and the Dry Romer Shoal finished, and supplemented by a system of mines, it is safe to say no hostile ship could enter the lower bay. With only 28½ ft. of water at high tide over the bar, entrance is forbidden to the largest foreign war-ships, but unless the defense can keep such vessels at a distance it would be quite possible for them to anchor in 30 ft. of water within eight miles of the Navy Yard and lower New York without crossing the bar, and reach those points with their projectiles.

Of the other cities on the coast, it may be said that at Portland 30 ft. can be carried to within half a mile of the wharves; Boston, 30 ft. to within five miles of the State House; Newport can be shelled from almost any position outside; 30 ft. can be carried to within 2½ miles of New London; any draft into Hampton Roads; at Charleston 14 and Port Royal 21 ft. over the bar; the largest vessels can approach Key West; 19½ ft. can be carried over the outer bar at Mobile, and 26 ft. through the Southwest Pass of the Mississippi. On the Pacific coast, San Francisco, Seattle and Port Townsend can all be approached by the heaviest iron-clads.

It will take a war between great maritime powers to determine the true value of torpedoes and mines in harbor defense. As has already been said, it is believed that too much is expected of these weapons. The lessons taught by our Civil War are misleading in that, in looking over the long list of vessels damaged or destroyed by their agency, it is apt to be forgotten that these were hastily built, single-bottomed, and, one may suppose, structurally weak specimens of naval construction, or were improvised from second-hand material. The double-bottomed, cellular compartment steel war-ship of to-day would have little to fear from the gunpowder torpedoes of the Confederates. Not only this, but the experiments made abroad with high explosives, notably those known as the *Oberon* and *Resistance* experiments, supplemented by others made in Italy and France, clearly indicate that very considerable charges of high explosives may be detonated near or against the bottom of a modern war-ship without putting it out of action.

When it is remembered that a single shell exploded in the shore "plant" of a system of controllable mines or torpedoes would probably put the whole system out of action, or that the breaking of a single electrical cable might accomplish the same thing, to say nothing of the nets, booms, etc., that would be used to neutralize the action of movable torpedoes, or the difficulty of operating this class of weapons in a harbor filled with floating ice, one is fully justified in the belief that if the main defense of harbor or water-way is ever left to mines and torpedoes, instead of to guns and batteries, the hour of need will demonstrate that reliance has been placed upon a broken reed.

## WATER-POWERS AND ELECTRICAL TRANSMISSION.

(From the *Electrical Engineer*.)

VARIOUS articles in this issue bear upon the important question of the electrical utilization of water power. The leading contribution on the subject is the admirable paper read before the Buffalo Electrical Society by Mr. Madison Buell, who has made a masterly compilation of the data of work in this line, and presents his results in a most attractive and instructive form. Another article is that descriptive of the work proposed at Lauffen, on the Neckar, in the transmission of 300 H.P. A third article deals with the installation for the extensive utilization of water-power electrically at Olympia, Wash., and a fourth gives some details of the work already begun at Joplin, Mo., where power and light are to be distributed over a wide area in a mining district.

It will be observed that Mr. Buell looks for the almost complete replacement of steam-engines by turbines through the use of electricity. While we share many of his opinions and much of his enthusiasm on the task that water-power has before it, we cannot go quite so far as he does. On the contrary, we believe that for an indefinite time to come the use of steam-engines will increase. The engines will grow in size and, by compounding and condensing methods, be made more and more economical of fuel or water. The great change that does lie before us is that, instead of having a large number of separate steam plants, we shall have central steam plants whose power will be cheaply and effectively distributed through the agency of electricity. This process has already begun, and the extension of motor service has the beneficial effect also of making the production of current for lighting cheaper too.

In a word, the rapid increase in water-power plants will not greatly affect, or be affected by, the existence of steam plants. Any change that comes will not be in the direction of abolishing a single agency we now enjoy, but rather by way of limiting each to the work for which it possesses undeniable advantages of economy, efficiency and availability. Moreover, while the water-powers still to be brought under the yoke represent an enormous total waste, the net power utilizable will be but a fraction of the sum. Thus Niagara takes the drainage of an area of nearly 250,000 square miles, but it is only a small part of Niagara that even the most sanguine engineer expects to put in harness.

It seems well to make these remarks in passing, as it is often said by way of criticism that electrical engineers in dealing with these questions are too fond of looking upon all the possibilities as actual achievements, and very slow to admit the existence of any insurmountable difficulties. If this be a fault, it is at least a pardonable one, and certainly Mr. Buell has made a magnificent showing of hard, honest and successful work in this field, not only in America, but in Europe and other parts of the world.

As demonstrating the advanced state of the art of the electric transmission of water-power as compared with its condition less than 10 years ago, we need only refer again to the experiments which have just concluded, and which constitute the preliminary tests of the transmission plant

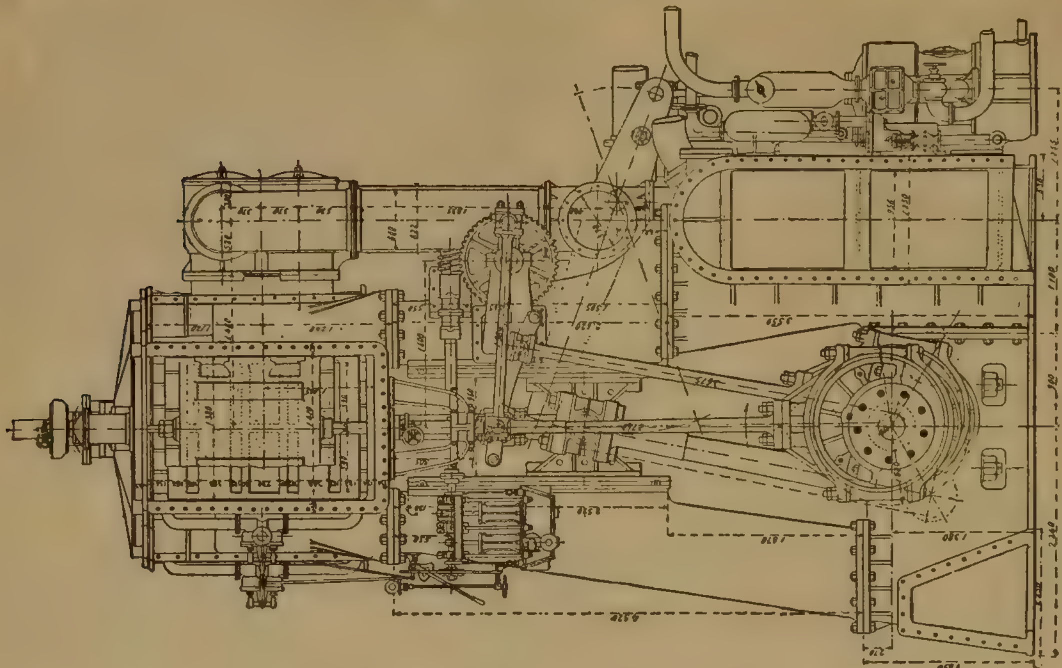


Fig. 4.

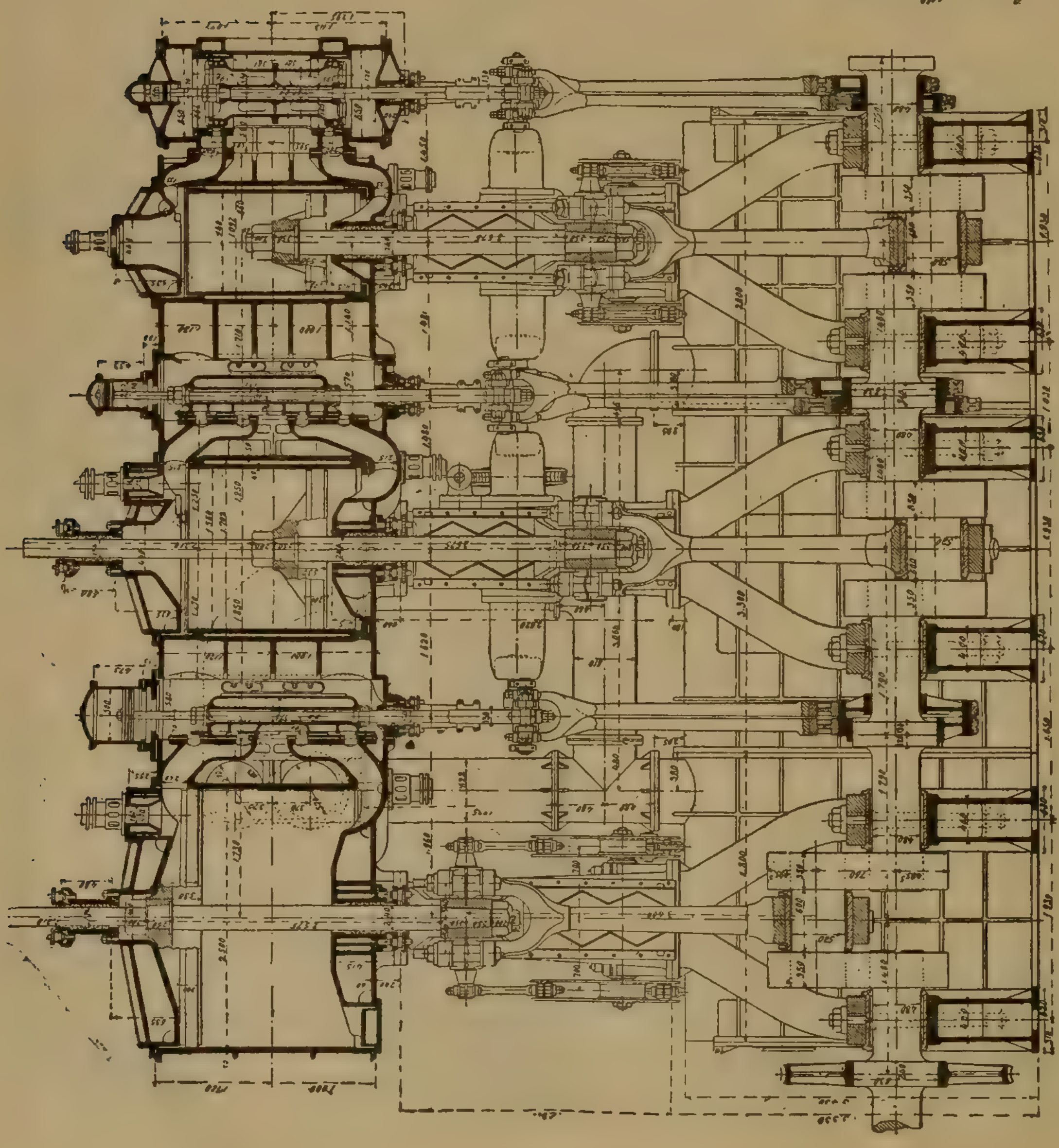


Fig. 1.

TRIPLE-EXPANSION ENGINES FOR ITALIAN STEAMER "SIRIO."

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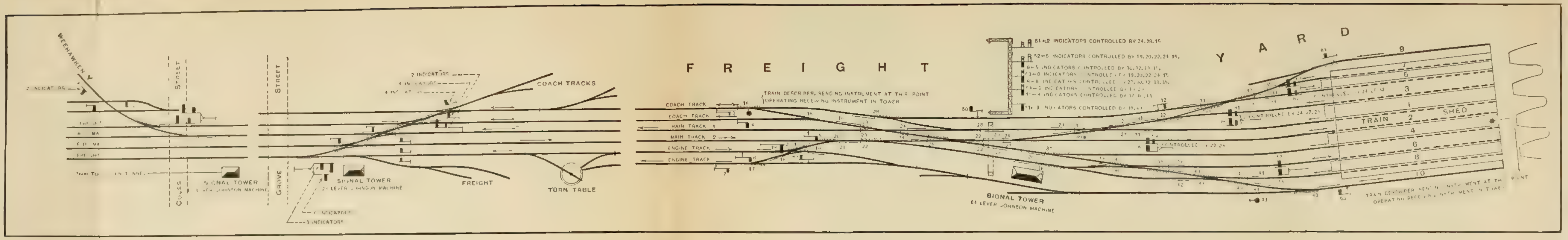



NEW INTERLOCKING AT THE JERSEY CITY TERMINAL PASSENGER STATION OF THE NEW YORK, LAKE ERIE & WESTERN RAILROAD

CONSTRUCTED BY THE JOHNSON RAILROAD SIGNAL COMPANY, RAHWAY, N. J.

## THE NEW INTERLOCKING AT THE ERIE TERMINUS IN JERSEY CITY

THE accompanying plan shows the new interlocking, recently constructed by the Johnson Railroad Signal Company, of Rahway, N. J., in connection with the Jersey City terminus of the New York, Lake Erie & Western Railroad. There are three towers—Coles Street, Grove Street, and the terminus. It is the intention of the Erie Company to make use of the new towers, in extending the Sykes block system to the terminus, by three additional block sections, substituting this system for the automatic banjo signals at present in use.

The terminus tower was brought into service on Sunday, May 3, at 10 A.M. Owing to the great number of train movements made between the hours of 8 A.M. and 10 A.M., and from 5 P.M. to 7 P.M., the levermen were given three weeks' instruction and practice, and three practice Sundays, working the traffic. There are three shifts of levermen, the two day shifts being each composed of three levermen and one foreman, and the night shift of two levermen and one foreman. All the men were taken from the yard, and had had no previous experience with interlocking. The foreman has a seat in the bay window, and his duty is to attend to the various audible and visual notices given on the "train describers," which connect with the Train Starter, the Yard Master, the Engine Despatcher, and Bergen West Tower. He acknowledges each notice by two beats of the bell. The train describers give him timely warning of the nature of the trains or engines moving or about to move either East or West. Each train describer is capable of 14 indications, all of which are transmitted by two lines and one battery. Grove Street has also one train describer, operated by Bergen West, for trains coming East. All important points are also connected by telephone, for use in cases of emergency. The train describers, telephones and bells are all conveniently located in the bay-window of the tower.

The Foreman has control of all train movements, and the levermen work in accordance with his verbal instructions. This arrangement was considered advisable, owing to the excessive congestion of traffic at certain times in the day. There are eight tracks in the train-shed, and the departure of passenger trains from these tracks is governed by starting signals mounted on continuations of the gate-posts at the rear of the shed. These signals are operated from a tower placed immediately above, and in easy communication with the Station-master's office. On the arrival of the last boats which are scheduled to connect with a particular train, from the up-town and down-town ferries, the boat slips are deposited in the Station-master's office, where they are signed and sent up to the signalman above, by means of a small tube. On receipt of the slips, he notifies the main signal tower, by a train describer, that a train is ready to depart from a certain track. As soon as the acknowledgment is received from the main tower, the small arm at the end of the track is lowered to the clear position, which informs the train conductor that his train must depart. At the same time the gate is closed.

The only unique signalling is that on the signal bridge. The bridge is so placed that the signals thereon govern movements from any track to any track, going either East or West. By the use of selectors, all the bridge signals are operated by eight levers. Without selectors the bridge signals would have required 36 levers. All the appliances are those of the Johnson Railroad Signal Company. A noticeable feature was the absence of trouble through the catching of locking. This trouble is very noticeable in bringing into use a Saxby & Farmer machine of corresponding size.

On the first day of opening—Sunday, May 3—there was no delay whatever; but when the rush came on Monday morning, the men became somewhat confused, and so delayed a few trains. They caught up with the time-table by 12 o'clock noon. The same thing occurred with the afternoon shift, but these men also caught up with the time-table by 7 P.M. On Tuesday morning there was a remarkable improvement in the speed with which the trains were handled, and no delay whatever took place. About 2 P.M. an accident occurred in the Bergen Tunnel, which completely stopped traffic both ways for three hours. There was naturally a rush when the tunnel was cleared, and Superintendent Stearns says that the shed was cleared in quicker time than had ever been the case before with the hand switches. Since then there has been a gradual improvement, so that the Erie Company expects presently to find plenty of room in what was formerly a cramped train-shed.

Mr. C. W. Buckholz, Chief Engineer of the New York, Lake Erie & Western Railroad, has had charge of the concentration and rearrangement of the switches, and also of the interlocking. Mr. Charles R. Johnson and Messrs. Henry and Arthur H. Johnson are the contractors' engineers.

The frogs and switches were supplied by the Pennsylvania Steel Company.

to be installed in connection with the Frankfort electrical exhibition to be held this year. It will be recalled that in 1882, Marcel Deprez carried out his famous experiment of transmitting the power of a waterfall at Miesbach to Munich, a distance of 37 miles. In that experiment, which is justly looked upon as the one which finally settled the question of the practicability of long distance power transmission, the potentials employed barely exceeded 1,800 volts, while the actual power obtained from the motor at the distant end did not exceed ½ H. P. We recall distinctly the objections raised at that time to the success of the system of transmission, among them being that of the inability of the armature to withstand successfully pressures exceeding very much the one employed. At that time, however, the alternating current had scarcely been hinted at, much less put in actual practice. To-day, however, the converter and alternating machine allow us to use potentials 20 times as great as that deemed safe only 10 years ago, by confining such high potentials to the outside circuits, and employing in the machine at the station the low tension current of conversion. Instead of ½ H. P. transmitted for 37 miles, it is contemplated to transmit 300 H. P. over 115 miles, and over a wire ⅙ in. in diameter, and at a potential of 30,000 volts. With these new methods at our command, the problem of economic transmission of water-powers takes on an entirely new complexion, and where once the cost of conductors acted as a deterrent to the undertaking of such work, the present methods relegate their consideration to an inferior position. The success of the proposed plant at Frankfort would, we are certain, open up a new era in electric power transmission for long distances, and at last lead to the realization of the predictions made 10 years ago, that not only Niagara but every other available water-power would be utilized through the medium of electricity.

## A TRIPLE-EXPANSION MARINE ENGINE.

(From the *Steamship*)

THE Italian General Navigation Company recently decided to change the engines of its large steamers *Sirio*, *Orione* and *Persio*, employed on the line between Italian ports and the Argentine Republic, with a view to increasing their speed. The former engines, although triple-expansion and of modern make, did not develop a power corresponding to their weight, so that the boats could not attain the desired speed. The construction of the new engines was entrusted to the works of G. Ansaldo & Company, of Sampierdarena, who are favorably known through many engines furnished for the Italian Navy, and possess excellent plant for work of this character. The new engines were to be triple-expansion, developing with a boiler pressure of 160 lbs. 5,000 indicated H. P. The efforts of the engineers of the firm were directed toward producing an engine of the greatest simplicity and perfection in all its parts, so that the result represented by our illustrations may be regarded as the best specimen of Italian marine engineering of the present time.

The engines are of the usual type for mercantile steamers, with three inverted cylinders, the diameters being 0.94 m. (37 in.) for the high-pressure, 1.55 m. (61 in.) for the intermediate, and 2.50 m. (98.5 in.) for the low-pressure cylinder, the stroke of the pistons being 1.52 m. (60 in.) for all of them. The valves are worked by a Stephenson link motion with open rods. The reversal of the engines is obtained by means of a small auxiliary engine with two coupled cylinders, which turn the reversing shaft by means of a worm or worm-wheel, and acts promptly and regularly. The condenser is placed longitudinally alongside the three engines, and is made in two parts that may be disconnected, so as to use one only while the other is being repaired. To the condenser two air-pumps and the usual feed and bilge-pumps are attached. The water circulation through the condenser is effected by means of two centrifugal pumps, with separate engines. For feeding the boilers several pumps on Weir's system, with independent motors, an auxiliary pump and air-pump, steering motors, etc., are provided. All parts are easily accessible, and the principal handles within reach of the engineer on a platform as usual. Steam is supplied by four large double-ended boilers with six furnaces each made of steel plates, with Purves furnaces. The total heating surface amounts to about 1,300 sq. m. (14,000 sq. ft.). Two funnels carry off the combustion products.

At the trial the engines were found to be easy to handle and to work regularly, with a good distribution of the stresses. Several trial trips were made in the Gulf of Genoa, both in quiet and rough weather, and these were very satisfactory as regards the working of all parts and facility of steering. Numerous diagrams were taken at

Fig. 2.

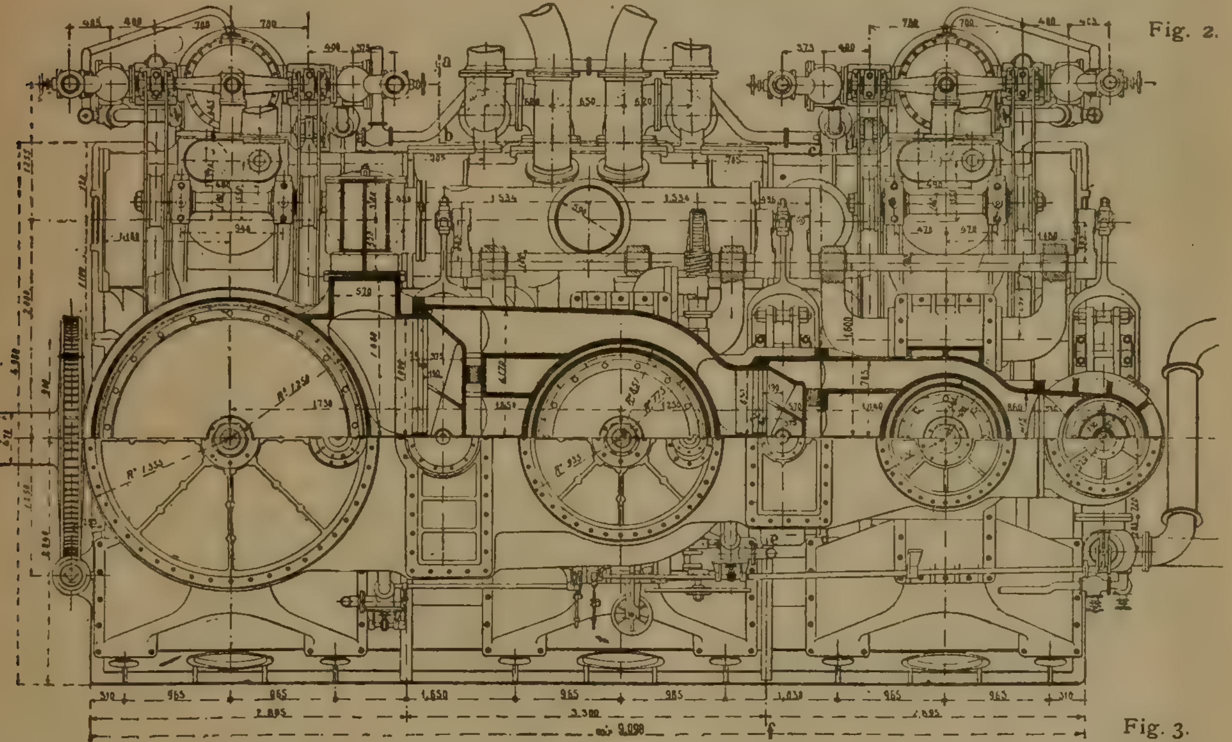


Fig. 3.

a speed of 75 revolutions, which was the maximum obtained, as well as at 70 and 68 revolutions, which proved that the power demanded from the engines with 70 revolutions was fully obtaiued ; and that it was not difficult to obtain 6,000 H. P. with 74 or 75 revolutions, 6,116 H. P. having been indicated on a run of 11⅓ miles. During the last trial of 6 hours 12 minutes, in which the average contracted power of 5,000 H. P. was maintained, the consumption of fuel amounted to 20.303 metric tons, or 1.43 lbs. per indicated H. P. per hour, which is a very satisfactory result, if we take into consideration that generally marine engines work most economically at a less power than the indicated power contracted for.

The crank-shaft is fitted with powerful double worm and worm-wheel gearing, shown at the left side of the illustrations, for which we are indebted to *L'Industria.* This serves to turn the crank-shaft slowly around for setting the valves and making other adjustments, and is no doubt a useful adjunct to engines of such large size as those described. The dimensions of the gearing are : Pitch diameter of large worm-wheel, 7 ft. 2 in.; pitch of teeth, 3 in.; number of teeth, 90 ; pitch diameter of worm, 12½ in. The dimensions of the first-motion gear are : Pitch diameter of wheel, 17.8 in.; pitch of teeth, 2 in.; number of teeth, 28 ; pitch diameter of worm, 4.8 in.

The length of the connecting-rods of the engine is 11 ft. 2 in. The condenser has 4,222 tubes ; the length between tube-plates is 11 ft. 4 in.; the total refrigerating surface is 9,345 sq. ft.

In the illustrations fig. 1 is a longitudinal section ; fig. 2 a half cross-section ; fig. 3 a half plan, and fig. 4 an end view.

## THE ACCIDENTAL VERIFICATION OF THE THEORY OF UNIVERSAL GRAVITATION.

By Professor J. Howard Gore, Ph.D.

We are indebted to a mistake for the theory of universal gravitation. This seems strange, and the curious chain of accidents that led up to this mistake are still stranger.

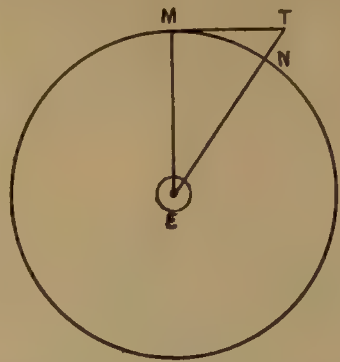
The name of Newton is familiar to all, and to many he is known as the discoverer of this wonderful theory. Its discovery was not accidental, but it had been sought and not found, and between the seeking and the finding laid the fortunate error.

At the age of 24—that is, in the year 1665—he was obliged to leave Cambridge, owing to the presence of a plague there, and go to his ancestral home at Woolsthorpe. There he found that quiet solitude that was so welcome to his student nature, and thus removed from the world's noisy bustle, his mind turned to the contemplation of physical phenomena. One of these was gravity ; and while trying to find some tangible clew to this mystic power of nature, it is said that he was aroused from his day-dream by the fall of an apple. Some assert that the apple struck him on the head, and so gave him an idea of the momentum acquired in falling. If he happened to be in a very brown study the blow would hardly suffice to awake him, if we may judge from the following anecdote :

Newton, when riding through the country, on one occasion came to a hill which he thought too steep for the horse to ascend with ease while encumbered with the rider, so he dismounted, and throwing the rein over his arm, he walked leisurely up the hill, leading the horse. Some interesting problem or idea took possession of his mind, causing him to be unconscious of his arrival at the top, nor did he think of mounting until fatigue suggested that riding was more agreeable than walking. He turned around to mount, but instead of finding his horse he found only the bridle, which he had been dragging.

Whether the apple hit him or not, whether it fell or not, it was while in the country that he began his speculations regarding gravity, reasoning that the force which draws downward a stone from the hand, an apple from the top of the highest tree, a drop of water from the loftiest cloud, might extend still further—drawing the moon to the earth, the earth toward the sun, with centrifugal force to keep all in place.

Thus a question was asked ; the problem stated challenged a solution. Nor was progress arrested until diagram and figures had exhausted their resources. Suppose $E$ be the earth and $M\ N$ the orbit of the moon—that is, the path the moon follows in revolving around the earth. It was known before Newton's time that the distance from the earth to the moon was 60 times the radius of the former. If the moon moved in a straight line, as it naturally would if not acted upon by some other force, at the end of a given time—say one second—it should be at $T$; but it was known to be at $N$—that is, the moon had fallen in one second toward the earth through the distance $T\ N$. This Newton surmised was the effect of gravity, the amount




of the attraction exercised on the moon by the earth. The fall $T\ N$ was known, the distance through which a body on the surface of the earth falls in one second was known, and the fact that within certain limits the force of gravity decreases as the square of the distance increases was accepted. If this law of gravity was true, $T\ N$ should be to 16 feet the distance a body falls in one second on the surface of the earth, in a proportion which was inversely as the square of the distance of the moon from the center of the earth was to the radius of the earth. This proportion gave for $T\ N$ a value one-eighth less than observation showed it to be.

Where was the trouble ? Either the hypothesis was wrong or else the data incorrect. Every element of the latter had been confirmed by repeated observers except the radius of the earth, and surely this must be right, for it was taken from the computations of a Cambridge man (Wright). Therefore this hypothesis, so brilliant in conception, must be laid aside as insufficient in action, and the failure of this Achilles being known by all the great men of England, checked further research in this direction. This was the seeking.

About this time he became so much absorbed in the beginnings of the calculus and theories of light that he "laid aside all thoughts concerning the moon." Not being impatient to rush into print, but preferring to work quietly and for his own pleasure, he seldom prepared for publication, but stopped as soon as he could with his prophetic vision see results confirming or disproving hypotheses. Therefore Hooke, secretary of the Royal Society of London, wrote to him, asking him to contribute something to the *Philosophical Transactions*, the organ of the Society. In 1683 he complied with the request, sending a little dissertation to refute the popular belief that, since the earth moved from west to east, all falling bodies would be left to the east ; maintaining that they would be left to the westward, and that the path of the body would not be a straight line. He drew on the margin of his paper a line to show the kind of path which would be described, but then, thinking that the diagram would add nothing to his paper, he crossed it out by running his pen along this line in a wavy manner, as we now often do. Hooke, thinking the spiral line was meant for the real path and the other line for the path of popular belief, wrote in haste, saying, "You surely do not mean to say that the falling body has a *spiral* path ?" As is well known, Newton shrunk from controversies, even of the most friendly character ; he therefore decided to work over the entire problem and extend upward the point from which the body was supposed to drop. As he carried this point higher and higher, he naturally

thought of his investigations made 18 years before concerning the universality of gravitation. And simultaneously with this thought came the recollection that a new determination had been made of the size of the earth ; perhaps he remembered that the former Secretary of the Royal Society had communicated to its members the results of this measurement. At all events, a search in the *Transactions*, published in 1675, disclosed a new value for the earth's radius found from arc measurements made by Picard.

Who was Picard ? He was a priest more interested in mathematics than in religion, who was fortunate in being a friend of Mouton, a priest at Lyons, who was a friend of Riccioli, a priest at Bologna, who owned a book written by Snell. Thus we go, step by step, like in the "House that Jack Built," down to Snell, and the question comes, Who was he ?

Snell was a Dutch mathematician who deserves our highest praise for conceiving and putting in successful operation the method now in use for determining the size of the earth by triangulation. His report was published in Leyden in 1617, and by some chance a copy of it reached the headquarters of the order of Jesuits at Bologna. It was seed falling in good ground, for it came into the hands of Riccioli, a member of that order. He was compiling a reformed geography, introducing the latest discoveries, and so revising old observations that the results might be free from incongruities, or at least be harmonious with one another. One of the elements on which no two agreed was the radius of the earth ; but to Riccioli the method of Snell appeared by far the best ; but before accepting it definitely he hoped some one else might test it.

Driven by the heat from Bologna, the Jesuit brethren repaired to their summer home on the mountain-side, and while there Riccioli, looking down upon the plains at their feet, saw a good place for a base line, and all around him were points well situated for trigonometric stations. This suggested that he himself should be the one to test the results of Snell and publish, at any rate, their average in his cyclopædic work. The execution soon followed the conception, and in a short time his results found their way into many cloisters and ecclesiastic homes. One of these was the collegiate institute at Lyons, where Mouton was director of the choir.

This chorister was interested not only in solemn chants and cadenced marches ; he found his greatest pleasure in musing on the harmony of nature and the music of the spheres. He saw discord in many conventional systems, especially in the system of measures, where the confusion of varieties was confounded by their uncertain relations. So he set himself to work to devise a system which should have a fixed and natural basis and a simplicity which would commend itself to all peoples. This was the aim of the proposers of the metric system ; now let us see how completely this forgotten priest antedated the French academicians by *one hundred and thirty* years, and surpassed them in form and comeliness.

When Riccioli's book reached Mouton, giving the length of a degree of the earth's meridian, the thought came to the latter that here was to be found a unit of measure. So he took the length of one minute of arc and then one-thousandth of a minute ; this he called a *virga ;* ten virga was a *decuria*, the Latin for by tens ; ten decuria was to be a *centuria*, meaning by hundreds ; and ten centuria a *milliar*, which was also the length of a minute of the earth's circumference. The virga was to be divided into ten parts, each called a virgula ; one tenth of this was a *decima*, meaning a tenth ; one-tenth of a decima was a *centesima*, meaning one-hundredth ; one-tenth of a centesima was a *millesima*, meaning one-thousandth. From this it can be seen that Mouton developed a decimal system and based it on the size of the earth, the two features which were the boast of the propounders of the metric system, and surpassed them in the terms which he employed, using words taken from only one language, and in their proper etymological sense.

Nor did he stop here. He showed how the length of his unit could be preserved by giving in terms of it the length of the pendulum making an oscillation in one second. This idea was adopted many years later by the English for preserving the length of the yard. In contemplating the great advance here made one must realize that this was in 1665, several years before Huygens announced his investigations regarding the pendulum.

The only way to account for the *complete* oblivion into which this wonderful work of Mouton fell is to say that he was far in advance of his time, and being a comparatively obscure man, his radical views found no adherents. The report of his scheme is published in a book treating of the apparent diameter of the sun and moon, but the book has been practically lost, and after two hundred years of forgetfulness it was only recently brought to light through my instrumentality.

Mouton and Picard, both in the priesthood, were friends, and were interested in the same subjects. Picard had visited Mouton, as he himself confesses, but he does not acknowledge in 1675, when he speaks in glowing terms of the possibility of using the pendulum to fix a unit of measure, that his friend, ten years before, had not only proposed, but had accomplished that very scheme. Picard's quick wit soon enabled him to see that here was a chance to distinguish himself, so, benefiting by what Mouton had done, he hastened to make a measurement of the circumference of the earth near Paris.

This was done with better instruments and greater care than had yet been used. Every part of his work we now know was blemished by errors. Fortunately for us they were of a compensating character, each one destroying some other, until the final result was quite near the truth.

This was the error.

We left Newton just as he had found this result of Picard's. When we return to him we see him rejoicing in the discovery that the diameter of the earth was about 1,000 miles more than he had heretofore supposed. Perhaps this new value might enable him to demonstrate the universality of gravitation. He tried it, and as the figures took their places in the computation under their master's direction and passed through the evolutions at his command, there began to dawn a result which would confirm his hypothesis and make of his theory an accepted fact.

This was an anxious moment for the hopeful philosopher, and so completely did he yield to this anxiety that he was obliged to ask a friend to complete the computation, nor did he find rest for his mind until there came to him the joyful news, "the figures check the fancied truth."

This was the finding.

The French astronomer stumbled more wisely than he knew ; the English philosopher harmonized theory with fact, applied the finite to the infinite, and harnessed the worlds with invisible traces.

## ARMY ORDNANCE NOTES.

In Washington, May 12, bids were opened in the Ordnance Bureau of the War Department for supplying steel forgings for 8-in., 10-in., and 12-in. guns for coast defense, and for armor-piercing projectiles for guns of these calibers. These bids may be summed up as follows :

*Gun Forgings :*

| | Bethlehem Iron Co. | Midvale Steel Co. |
|---|---|---|
| 10 sets for 8-in. guns | 28¼ cts. per lb. | 29 cts. per lb. |
| 10 sets for 10-in. guns | 28¼ " " | 27 " " |
| 10 sets for 12-in. guns | 28¼ " " | 27 " " |

*Armor-Piercing Shells :*

| | Carpenter Steel Co. | Midvale Steel Co. |
|---|---|---|
| 104 for 8-in. gun | $15,288 | $14,500 |
| 208 for 10-in. gun | 57 408 | 58,425 |
| 52 for 12-in. gun | 24,960 | 25,000 |

The bid of the Bethlehem Iron Company was conditioned on an order for all the forgings ; if a portion only should be taken, the price named was 30 cents. As an alternative bid, the Bethlehem Company offered to supply 11 sets of 8 in. forgings, 10 sets of 10-in., and 11 sets of 12-in. at $800,000. This bid, however, was for lower-weight forgings than are called for.

It is understood that the contract for the gun forgings

will be awarded to the Midvale Company and that for the shells to the Carpenter Steel Company.

## TESTS OF A COMPOUND LOCOMOTIVE.

By F. W. Johnstone, Superintendent Motive Power, Mexican Central Railway.

The account given below is of a comparative test of a simple consolidation engine and a compound consolidation engine, in the same service on a mountain section of the Mexican Central Railway.

### DESCRIPTION OF ENGINES.

The simple high-pressure consolidation engine, No. 107, selected for the trial, is a Baldwin locomotive of recent design with ample boiler capacity, 20 × 24 in. cylinders and 48 in. drivers. This engine had just been thoroughly overhauled in the Mexico City shops, and was in perfect condition when the tests were made.

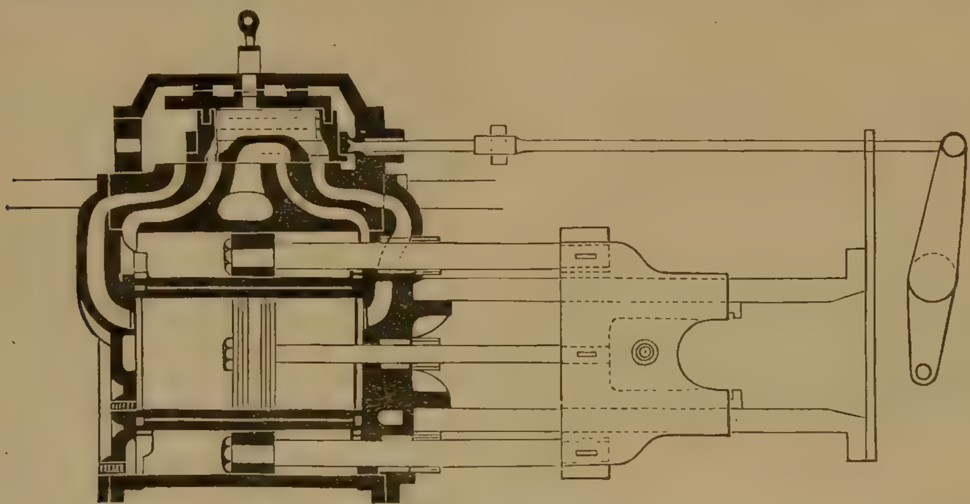
(Mexico). It was decided to make the change on this Rogers consolidation engine. This work was not allowed to interfere with the regular work of the shops, but was carried on from time to time as circumstances would admit, so that it was just about 12 months from the commencement of the work to its completion. As it was necessary to put in a new fire-box, it was decided to increase its length to 9 ft. 4 in. The engine was stripped and the boiler work done outside, while the patterns and castings were being made for the compound cylinders.

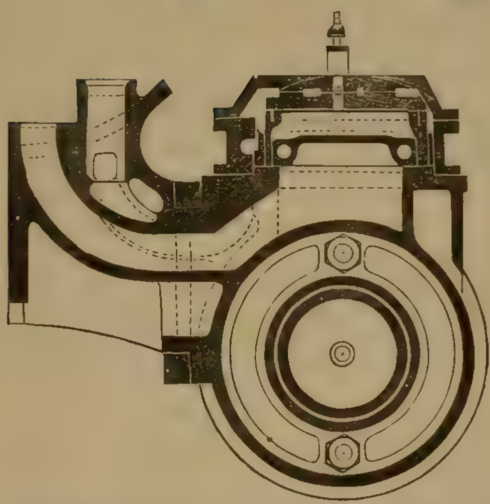
The principle adopted by the Superintendent of Motive Power, Mr. F. W. Johnstone, will be readily understood by referring to fig. 1. It will be seen that the high-pressure cylinder, which is 14 in. diameter by 24 in. stroke, is placed within the low-pressure cylinder, which is 30¾ in. diameter by 24 in. stroke, or equal to a cylinder of 24¼ in. diameter after deducting area of high-pressure cylinder and the sleeve surrounding it.

The ratio of the cylinders is three to one.

The low-pressure piston is provided with two rods, and the high-pressure with one; the three rods are secured to the

Fig. 1.





same cross-head, both pistons acting in the same direction.

The valve, which is a very important feature of this design, is so constructed as to distribute steam to both high and low-pressure cylinders, requiring but one valve-stem, which is actuated by the link motion as formerly used on the locomotive, no change having been made in it.

The valve is made in two sections, the outer portion distributing steam to the high-pressure cylinder, and the inner section to the low-pressure cylinder. The inner section is carried by the outer, and has one inch less travel, the outer traveling 6 in. and the inner traveling 5 in. The object of this is to retard the point of cut-off to the low-pressure cylinder and also to reduce the compression on the front of the high-pressure piston. By reference to the indicator cards it will be seen that this has been accomplished in a very satisfactory manner.

For instance, when the high-pressure admission is cut off at 9 in. the low-pressure continues open to the admission of steam for 17 in. On the other hand, the compression on the high-pressure piston which would begin at 9 in. piston travel, were both sections of valve made to move together with the same point of cut-off, does not take place until 17 in. in the high-pressure piston and 19 in. in the low-pressure. With 14 in. cut-off in the high-pressure cylinder we get 20 in. cut-off in the low-pressure cylinder, compression beginning at 20 in. in the high pressure and 22 in. in the low pressure.

A simple arrangement of starting valves enables the engineman to throw the engine into high pressure, steam being admitted through a reduced opening—through the small valve shown on top of the steam-chest in fig. 1—into the low-pressure cylinders; when this is done the high-pressure piston is put into equilibrium, but the two low-pressure pistons act with a force equal to two 24¼ in. pistons; therefore, the engine has a much larger starting power than any high-pressure locomotive of ordinary build.

The compound engine, No. 66, was originally a Rogers consolidation, built in 1882, with 20 × 24 in. cylinders and 50 in. drivers, weighing 82,000 lbs. on the drivers, fire-box inside of frames and only 6 ft. long. This engine was so inefficient, it was decided when taken out of service for general repairs, to let it lay outside and await its chances of occupying a pit in the shops, which were always crowded with work upon more useful engines.

In August, 1889, the advisability of trying the compound principle on this road was discussed by the General Manager and Superintendent of Motive Power Department, with the view of ascertaining what saving could be effected in the consumption of fuel, which is the heaviest item of expense in the operation of railroads in this country

THE TESTS.

The tests were carefully conducted by Mr. E. V. Sedgwick, Master Mechanic of the San Luis Potosi Division, assisted by Mr. J. H. Ebert, Traveling Engineer.

The crew in charge of engine No. 107 were Messrs. W. H. Spicer, engineer, and N. Campos, fireman. The compound engine, No. 66, was under the charge of Messrs. George B. Ridgely, engineer, and G. A. Daily, fireman. These crews were selected for their ability in getting good work out of their engines, and had been handling these engines for two months before the trial began.

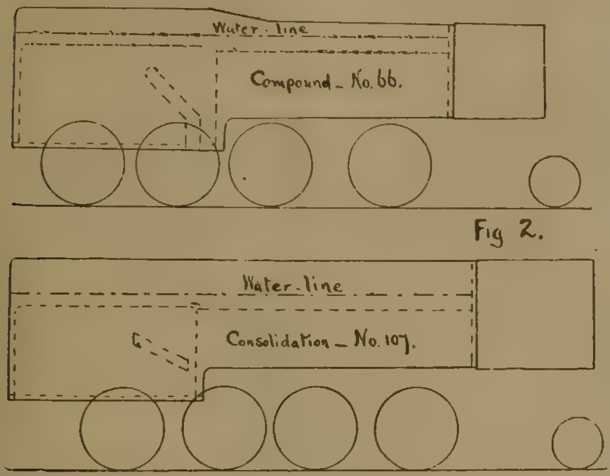



Fig 2.

It was decided to keep the record of trips between San Juan del Rio and Mexico City, as it was always possible to get full trains out of the former place, and these trains generally came through without breaking bulk.

The trains were weighed on track scales after having been made up and just before starting. A coal car was fitted up with a platform in the center provided with platform scales; this car was coupled to back of tank and all coal put upon the tender was weighed in boxes and taken up an incline formed by two planks reaching from platform on coal car to back of tender. The coal car was hauled on each train, as it was desirable to keep a record of the performances of engines on the continuous grade from San Juan del Rio to Cazadero, as well as a record of the performance over the entire division.

While the engine was standing in the engine house at San Juan del Rio steam was kept up with wood, the tender was emptied of all coal, and a quantity thought to be sufficient to take the train to Cazadero was weighed and placed upon it. The boiler was given a half glass of water, and fire was made up with coal which had been weighed out to the engine. This was generally done about 30 minutes before starting out with train. If the coal weighed out to the engine was not sufficient to take the train to Cazadero, more coal was put upon the tender while running, and any coal remaining on the tank after reaching Cazadero was weighed and the amount deducted from the total. The same was done upon arrival at Mexico.

The quantities of water used was arrived at in the following manner. A glass tube 5 ft. long was placed on each side of the tank centrally, fore and aft, and connected to bottom of tank by pipes and suitable stuffing-boxes to make joint at bottom of glass tubes, the upper ends being left open. These tubes were protected by brass pipes with slots cut nearly their entire length to admit of water level in glass tubes being seen. The tank was filled with water, and the level, shown in the two glass tubes was marked O on the brass pipes; water was then drawn off into a barrel which had been carefully weighed, precaution having been taken to fill the barrel and let it soak over night to insure getting the weight of the empty barrel correctly. The barrel was placed upon scales and filled until it contained $333\frac{1}{3}$ lbs. of water, then gauged at water-line. Therefore, in measuring the tanks every three barrels of water drawn represented 1,000 lbs., and the level in glass tubes noted and marked accordingly for each 1,000 lbs. drawn from the tank.

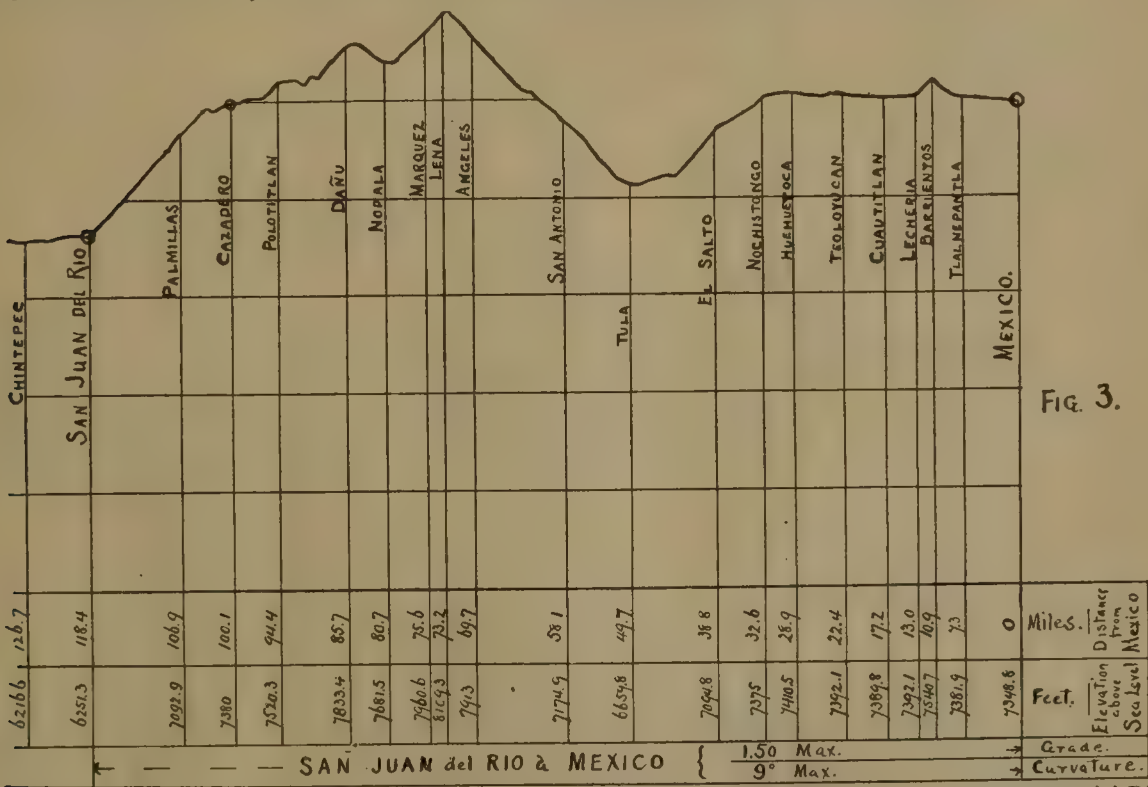



Fig. 3.

Before starting fire with coal at San Juan del Rio the water in the boiler was regulated to half glass and the height of the water in the tank noted, the mean of both tubes being recorded. When a water station was reached the height of water in the tender was noted both before and after taking water. As the 1,000-lb. marks on tubes were about 2 in. apart, it was an easy matter to ascertain accurately the quantity of water used between any given points. The water lost through the overflow of the injec-

tors (Sellers' improved) was so inconsiderable it was not taken account of. On the first trip this waste water was caught and measured and found to be so little that no further effort was made to take it into account. The blow-off cocks were used as sparingly as possible, and when used no account was taken of water thus thrown away.

These engines were not favored in any way; they laid over at sidings to await other trains, and did more or less switching at various points each trip, the object being to simply keep a record of coal and water used while engines were doing their regular duty in freight service. The engineers were not interfered with, but allowed to handle the engines as they had been accustomed to do.

Indicator cards were taken from each engine merely to show the action of the valve-gear, and not for the purpose of attempting to arrive at the work performed by the engine for the trips, or for any given distance or space of time during the trip, as the horse-power developed by a locomotive is constantly varying, and cards taken but a few minutes apart show that no reliance can be placed upon this method of ascertaining the amount of work done by a locomotive over a section of road, even when the grades are quite uniform. Seeing the necessity for a more comprehensive method of arriving at the duty of a locomotive in regular service for a trip or for a month's work, the Superintendent of Motive Power decided in the latter part of 1884 to reduce the work done by all engines in freight and passenger service to so many "Units of Work" performed.

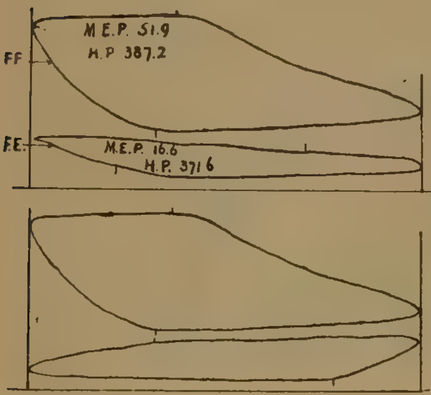



FIG. 4.
ENG. 66.
Cut-off, H.P. ... 9 in
" " L.P. 16¼
Compression begins, H.P. 16¼
" L.P. 19
Boiler Pressure .... 150
Revolutions ..... 200

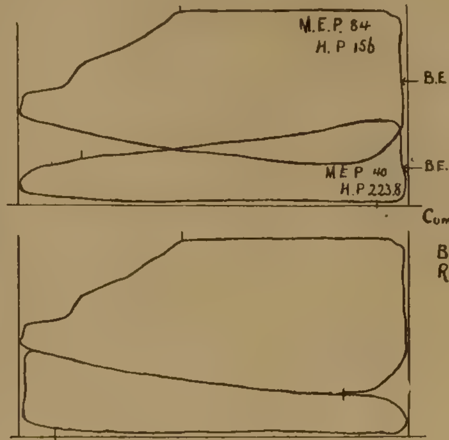



FIG. 7.
ENG. 66.
Cut-off, H.P. ... 14 in.
" " L.P. .. 20
Compression begins, H.P. 20
" " L.P. 22
Boiler Pressure. .. 150
Revolutions .. ... 50

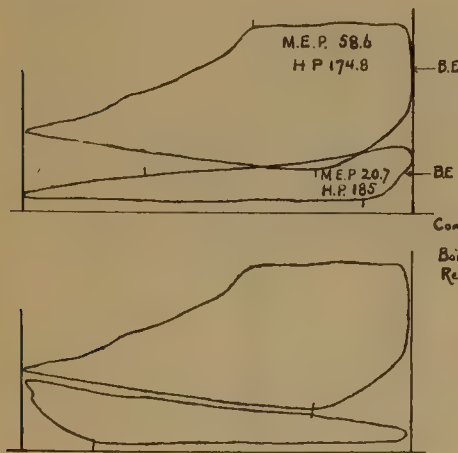



FIG. 5.
ENG. 66.
Cut-off, HP. 10 in.
" " LP. 17½
Compression begins, HP 17½
" " LP. 20
Boiler Pressure .. 150
Revolutions ... 80

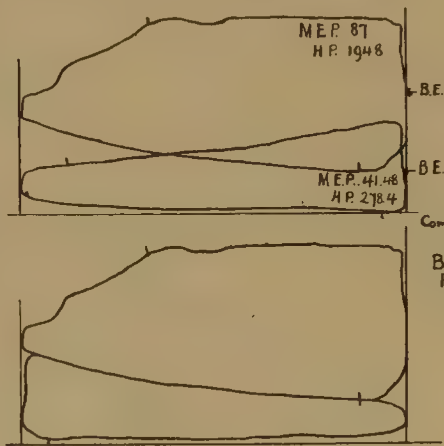



FIG. 8.
ENG. 66.
Cut-off, H.P... 16 in.
" " L.P.. 21
Compression begins, H.P. 21
" " L.P. 22½
Boiler Pressure .... 150
Revolutions ... 60

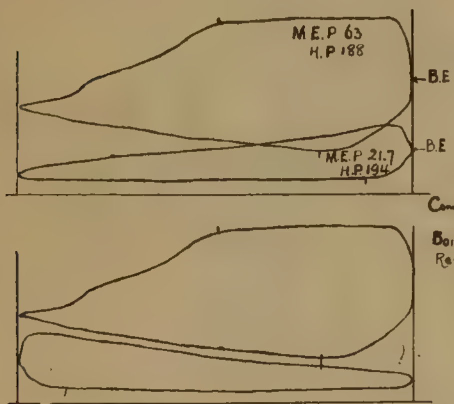



FIG. 6
ENG. 66.
Cut-off, H.P. .... 12 in
" " L.P. .... 18½
Compression begins, H.P. 18½
" " L.P. 21½
Boiler Pressure ... ...140
Revolutions ...... 80

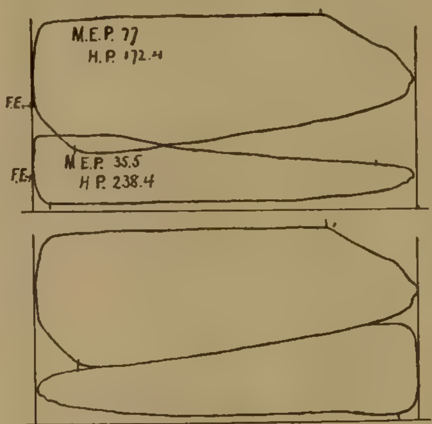



FIG. 9.
ENG. 66.
Cut-off, H.P. ... 18 in.
" " L.P. .. 21½
Compression begins, H.P. 21½
" " L.P. 23
Boiler Pressure .. 150
Revolutions ..... 60

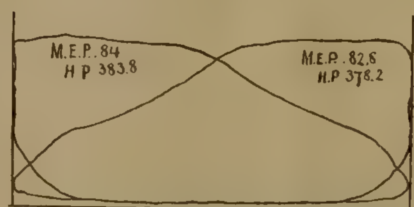



FIG. 10.
ENG. 107.
Cut-off.... 13 in.
Compression begins .. 19
Boiler Pressure .. 140
Revolutions.... 60

TABLE No. 1.

LOCOMOTIVE DIMENSIONS.

| LOCOMOTIVES. | No. 66, COMPOUND. | No. 107, CONSOLIDATION. |
|---|---|---|
| Cylinder size | 14″ × 24″ | 20″ × 24″ |
| Ratio L. P. to H. P. | 3 to 1 | . . |
| Driving-wheel diameter | 48 | 48 |
| No. of drivers | 8 | 8 |
| Weight on drivers | 100,000 lbs. | 100,000 lbs. |
| Weight of engine and tank | 180,000 lbs. | 180,000 lbs. |
| Diameter of shell of boiler | 52 | 60 |
| No. of tubes | 200 | 196 |
| Size and length of tubes | 2″ × 11′ : 7″ | 2¼″ × 13′ : 1″ |
| Grate area in square feet | 21.5 | 30.4 |
| Heating surface of fire-box in square feet | 148 | 152 |
| Heating surface of tubes in square feet | 1,200 | 1,489 |
| Total heating surface | 1,348 | 1,641 |
| Working boiler pressure | 150 | 150 |
| Water capacity of boiler in per cent | 100 | 118 |
| Steam space of boiler in per cent. with water 6″ above crown sheet | 100 | 168 |
| Grate areas of boiler in per cent | 100 | 141 |

TABLE No. 2.

PERFORMANCE OF LOCOMOTIVES BETWEEN SAN JUAN DEL RIO AND MEXICO, USING BITUMINOUS COAL FROM THE MINES OF SAN ANTONIO, N. M.

| | ENGINE 66. | | ENGINE 107. | |
|---|---|---|---|---|
| Date of trips | Nov. 15, 1890. | Nov. 25, 1890. | Dec. 10, 1890. | Dec. 12, 1890. |
| Total hours on trip | 13.20 | 13.40 | 13.13 | 11.35 |
| Actual running time | 10.00 | 10.40 | 9.05 | 7.45 |
| No. of cars in trains | 14 | 15 | 16 | 14 |
| Total weight of train, including engine and tender, in tons of 2,000 lbs. | 494 | 489 | 483 | 507 |
| Total units of work performed | 1,613 | 1,598 | 1,477 | 1,590 |
| Pounds of coal consumed | 13,300 | 13,200 | 15,800 | 16,000 |
| Pounds of water used | 74,000 | 73,000 | 82,000 | 83,000 |
| Units of work per ton coal | 242.6 | 242.1 | 186.9 | 198.7 |
| Units of work per ton of water | 43.6 | 43.8 | 36.0 | 38.3 |

RESULT.

Average of two trips shows the Compound Engine 66 doing 24 per cent. more units of work per ton of coal and 18 per cent. more units of work per ton of water than Engine 107.

One hundred gross tons hauled one mile at a very low rate of speed over a straight and level track was taken as a "Unit of Work." The profile of the road was carefully studied and the line reduced to an equivalent of a straight and level track (curves being compensated were left out of the calculation).

Tables were then formed to facilitate the computation of the units of work performed by each locomotive during the month. Separate tables had to be made up for passenger and freight service, as that for passenger trains was based upon a speed of 31 miles per hour, while the freight train table was based upon 16 miles per hour. This was necessary, as the resistance due to speed is different for the two classes of service.

In arriving at the work done all changes in the weight of trains are taken into account, and the units of work performed between any two points with a given weight of train is shown by the tables. The weight of train is taken from conductors' reports of loaded and empty cars, weight of engine and tender added. Loaded cars average at 24 tons and empty cars at 12 tons. These figures have been checked with the year's gross and net ton-miles and found to be very accurate. This system has been in use on the Mexico Central Railroad for the past six years, and has proved most satisfactory. The performance of light engines on level divisions can thus be compared with that of heavy engines on the mountain divisions. The premiums given for the most economical use of fuel are determined by the units of work per ton of coal shown on Performance Sheet for the month.

These years of experience having established the correctness of this method, it was decided to base the performance of the engines in the tests upon the units of work performed. But to be entirely assured as to the weight of the trains, each train was weighed before start-

TABLE No. 3.

PERFORMANCE OF LOCOMOTIVES BETWEEN SAN JUAN DEL RIO AND MEXICO, USING ENGLISH BITUMINOUS COAL.

| | ENGINE 66. | | ENGINE 107. | |
|---|---|---|---|---|
| Date of trips | Jan. 17, 1891. | Jan. 20, 1891. | Jan. 2, 1891. | Jan. 4, 1891. |
| Total hours on trip | 15.20 | 11.45 | 9.10 | 10.45 |
| Actual running time | 10.00 | 7.30 | 7.20 | 8.40 |
| No. of cars in train | 14 | 14 | 15 | 15 |
| Total weight of train, including engine and tender, in tons of 2,000 lbs. | 491 | 492 | 424 | 431 |
| Total units of work performed | 1,604 | 1,607 | 1,385 | 1,408 |
| Pounds of coal consumed | 12,000 | 12,090 | 12,900 | 13,100 |
| Pounds of water used | 69,000 | 70,000 | 73,000 | 74,000 |
| Units of work per ton coal | 267.3 | 266.0 | 214.7 | 214.9 |
| Units of work per ton water | 46.4 | 45.9 | 37.9 | 38.0 |

RESULT.

Average of two trips shows the Compound Engine No. 66 doing 24 per cent. more units of work per ton of coal and 21 per cent. more units of work per ton of water than Engine No. 107.

TABLE No. 4.

PERFORMANCE OF LOCOMOTIVES BETWEEN SAN JUAN DEL RIO AND MEXICO, USING ENGLISH PATENT FUEL (BRIQUETTES OF PRESSED COAL).

| | ENGINE 66. | | ENGINE 107. | |
|---|---|---|---|---|
| Date of trips | Jan. 11, 1891. | Jan. 15, 1891. | Dec. 27, 1890. | Dec. 30, 1890. |
| Total hours on trip | 12.02 | 15.25 | 13.00 | 11.05 |
| Actual running time | 10.00 | 9 00 | 7.25 | 8.45 |
| No. of cars in train | 15 | 14 | 16 | 16 |
| Total weight of train, including engine and tender, in tons of 2,000 lbs. | 506 | 491 | 455 | 438 |
| Total units of work performed | 1,653 | 1,604 | 1,426 | 1,431 |
| Pounds of coal consumed | 10,800 | 10,700 | 11,900 | 11,800 |
| Pounds of water used | 75,000 | 73,000 | 81,000 | 80,000 |
| Units of work per ton coal | 306.0 | 300.0 | 239.6 | 242.5 |
| Units of work per ton water | 44.0 | 43.9 | 35.2 | 35.8 |

RESULT.

Average of two trips shows the Compound Engine No. 66 doing 25.7 per cent. more units of work per ton of coal and 24 per cent. more units of work per ton of water than Engine No. 107.

TABLE No. 5.

PERFORMANCE OF ENGINES ON CONTINUOUS 1¼ PER CENT. GRADE FROM SAN JUAN DEL RIO TO CAZADERO, USING COAL FROM THE MINES OF SAN ANTONIO.

| | ENGINE 66. | | ENGINE 107. | |
|---|---|---|---|---|
| Date of trips | Nov. 15, 1890. | Nov. 25, 1890. | Dec. 10, 1890. | Dec. 12, 1890. |
| Hours on trip | 2.20 | 2.15 | 2.10 | 2 05 |
| No. of cars in train | 14 | 15 | 16 | 14 |
| Total weight of train, including engine and tender, in tons of 2,000 lbs | 494 | 489 | 483 | 507 |
| Pounds of coal consumed | 4,150 | 4,100 | 5,100 | 5,400 |
| Pounds of water used | 19,000 | 18,000 | 20,100 | 23,000 |
| Pounds of water evaporated per lb. of coal | 4.5 | 4.4 | 3.9 | 4.2 |
| Pounds of coal burned per square foot of grate surface per hour | 84.8 | 80.0 | 77.5 | 85.4 |
| Pounds of water evaporated per square foot of heating surface per hour | 5.6 | 5.9 | 5.7 | 6.7 |
| Total units of work performed | 499 | 494 | 488 | 512 |
| Units of work per ton coal | 241 | 241 | 191 | 190 |
| Units of work per ton water | 52.5 | 44.9 | 48.5 | 44.5 |

RESULT.

Average of two trips shows the Compound Engine 66 doing 26 per cent. more units of work per ton of coal and 15 per cent. more units of work per ton of water than Engine 107.

TABLE No. 6.

PERFORMANCE OF ENGINES ON CONTINUOUS 1½ PER CENT. GRADE FROM SAN JUAN DEL RIO TO CAZADERO, USING ENGLISH BITUMINOUS COAL.

| | ENGINE 66. | | ENGINE 107. | |
|---|---|---|---|---|
| Date of trips | Jan. 17, 1891. | Jan. 30, 1891. | Jan. 2, 1891. | Jan. 4, 1891. |
| Hours on trip | 2.20 | 2.20 | 2.10 | 2.00 |
| No. of cars in train | 14 | 14 | 15 | 15 |
| Total weight of train, including engine and tender, in tons of 2,000 lbs. | 491 | 492 | 424 | 431 |
| Pounds of coal consumed | 3,700 | 3,600 | 4,000 | 4,000 |
| Pounds of water used | 20,000 | 19,000 | 20,000 | 20,500 |
| Pounds of water evaporated per lb. of coal | 5.4 | 5.2 | 5.0 | 5.1 |
| Pounds of coal burned per square foot of grate surface per hour | 73.8 | 71.6 | 60.8 | 65.7 |
| Pounds of water evaporated per square foot of heating surface per hour | 6.3 | 6.4 | 5.6 | 6.2 |
| Total units of work performed | 496 | 497 | 428 | 435 |
| Units of work per ton coal | 268.0 | 276.0 | 214.0 | 217.5 |
| Units of work per ton of water | 40.6 | 52.3 | 42.8 | 42.4 |

RESULT.

Average of two trips shows the Compound Engine 66 doing 26 per cent. more units of work per ton of coal and 19 per cent. more units of work per ton of water than Engine 107.

TABLE No. 7.

PERFORMANCE OF ENGINES ON CONTINUOUS 1½ PER CENT. GRADE FROM SAN JUAN DEL RIO TO CAZADERO, USING ENGLISH PATENT FUEL (BRIQUETTES OF PRESSED COAL).

| | ENGINE 66. | | ENGINE 107. | |
|---|---|---|---|---|
| Date of trips | Jan. 11, 1891. | Jan. 15, 1891. | Dec. 27, 1890. | Dec. 30, 1890. |
| Hours of trip | 2.30 | 2.15 | 2.00 | 2.10 |
| No. of cars in train | 15 | 14 | 16 | 16 |
| Total weight of train, including engine and tender, in ton of 2,000 lbs. | 506 | 491 | 455 | 438 |
| Pounds of coal consumed | 3,300 | 3,200 | 3,700 | 3,600 |
| Pounds of water used | 22,000 | 20,700 | 22,500 | 25,000 |
| Pounds of water evaporated per lb. of coal | 6.7 | 6.5 | 6.1 | 5.7 |
| Pounds of coal burned per square foot of grate surface per hour | 61.3 | 66.2 | 60.6 | 55.0 |
| Pounds of water evaporated per square foot of heating surface per hour | 6.5 | 6.8 | 6.8 | 5.8 |
| Total units of work performed | 511 | 496 | 460 | 442 |
| Units of work per ton coal | 309 | 310 | 249 | 246 |
| Units of work per ton water | 46.4 | 47.9 | 40.8 | 43.1 |

RESULT.

Average of two trips shows the Compound Engine 66 doing 25 per cent. more units of work per ton of coal and 12 per cent. more units of work per ton of water than Engine 107.

ing, as stated above. The trains were composed of cars bound for Mexico, and only in a few instances was the bulk of the train broken, and when this was done a careful note was taken of this change in weight.

Table No. 2 shows two trips of each engine while using American coal. Table No. 3 shows two trips of each engine using English bituminous coal. Table No. 4 shows two trips of each engine using English patent fuel (briquettes of compressed coal). These 12 trips were made over the entire division of 118 miles; the profile of road is given in fig. 3.

Tables Nos. 5, 6 and 7 show performance of the engines with the three kinds of coal between San Juan del Rio and Cazadero, on a continuous grade of 1½ per cent.

The result of the tests show that the compound engine, No. 66, has effected an economy of 25 per cent. in fuel, and from 12 to 23 per cent. in water over the consolidation engine No. 107.

By reference to Table No. 1 it will be seen that the grate area, heating surface, and boiler capacity, both in water and steam space, of the compound is very much less than that of engine No. 107. With these facts in view it is very evident that by compounding engine No. 107 more than 25 per cent. economy can be effected in coal consumption.

It will be noticed that the economy in water is not as great as in coal when comparing the compound with the consolidation, No. 107. This is accounted for by the fact that engine No. 107 has 68 per cent. more cubic feet of steam space, and delivered much dryer steam to its cylinders. Owing to the small boiler of the compound it was impossible to work the engine very hard on account of the quantity of water which was entrained with the steam. The relation of water and steam spaces is shown in fig. 2. This was very noticeable in taking indicator cards, not so much in the low-pressure as in the high-pressure cylinders. When working hard with lever set to cut-off at 18 in. and throttle wide open, it was necessary to carry the water as low in the boiler as was safe to avoid passing water over into the cylinders. No difficulty of this kind was experienced with engine 107.

Given a boiler with the capacity of that of engine No. 107, the compound would most certainly have shown an economy in water equal to that in coal, and in using less water the economy in coal would be greater than these tests have shown.

The indicator cards above referred to are given in figs. 4–10 herewith.

A photograph of the compound engine was received too late to have it engraved for this number of the JOURNAL, but it will be given in our next number.

## THE MAXIM FLYING MACHINE.

A RECENT number of the New York *Herald* reports an interesting interview with Mr. Hiram J. Maxim, who spoke as follows about his plans for a flying machine:

"If I can rise from the coast of France, sail through the air across the Channel, and drop half a ton of nitroglycerine upon an English city, I can revolutionize the world. I believe I can do it if I live long enough. If I die some one will come after me who will be successful where I failed."

Mr. Maxim has built at his workshop near Kent, England, a small flying machine, with a wooden screw as its motive power. The screw revolves all the way from 1,000 to 2,800 revolutions per minute.

"What is your machine like?" he was asked.

"My first machine was a small one. It was an inclined plane, 13 ft. long and 4 ft. wide, and set edgewise against the air. I balanced it on an arm, about 30 ft. in length, revolving in a circumference of 200 ft. The arm was movable, so that it would rise and fall. When the machine traveled at the rate of 30 miles an hour it remained on the same plane. When the speed was increased to 35 miles it began to rise. At 90 miles it pulled its guy wires with such force that it broke them, and now we have to keep it chained. All our experiments were conducted with the greatest accuracy. Delicate machines measured the speed per minute and per hour, the push and lifting power of the screw, the horse power of the motor and every other factor."

"But this little machine can hardly be of practical use?"

"Very true; but now I am at work on a large machine, built of silk and steel that will do on a large scale what the other machine does on a smaller scale. We found by experiment that one horse power will carry 133 lbs. at the rate of 75 miles an hour. We proved also that our screw would easily lift 40 times as much on a plane that it propelled as it could push. I have built a motor weighing 1,800 lbs., and which pushes 1,000 lbs. It will therefore lift 40,000 lbs. The weight of my engines, generator, condenser, water supply and petroleum, and of two men is 5,000 lbs. So you see what a margin I have left."

"What is the size of your large machine?"

"It will be 110 ft. wide and 40 ft. long. It will be propelled by two immense wooden screws, nearly 18 ft. in diameter, looking very much like the screws of ocean steamers, only with broader blades. The steam is generated by heating copper by petroleum, and is condensed after being used, so that we get along with two gallons of water. The boiler is of the finest Whitworth steel, and we will use about 40 lbs. of petroleum per hour."

"How are you going to test the machine?"

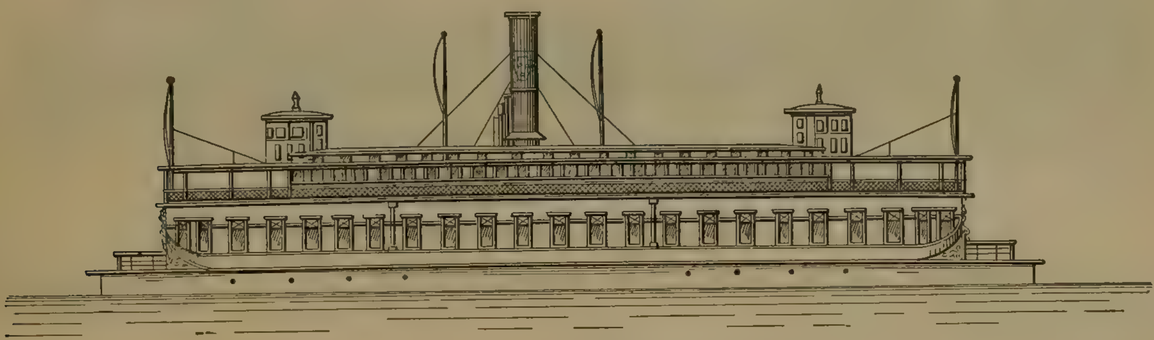
"It will be placed at an angle of about 1 ft. in 18 in. on a railroad track 12 ft. wide. At 30 miles an hour it will barely skim along, the pressure of the air underneath it being then equal to one pound for each square foot, or sufficient to just lift it. At 35 miles an hour it will begin to rise, and as the speed increases it will mount higher and higher. When you want to descend you will slacken speed, or if you wish to proceed on a straight line on a certain height you come back to 30 miles an hour. It can be done as sure as fate. I have spent $45,000 already upon it, and I did not enter upon the work until I was convinced that the idea was practical."

"But suppose you should tip over?"

"Oh, no," said Mr. Maxim, with a laugh. "You may be sure that that is one contingency that we are bound shall not occur. It will be impossible for the machine to fall forward, to sink backward or fall over."

## THE PENNSYLVANIA TERMINAL IMPROVEMENTS.

THE accompanying illustration is an elevation of the new ferry-boat *Cincinnati*, recently launched from the yard of Samuel L. Moore & Sons, at Elizabethport, N. J.



DOUBLE SCREW FERRY-BOAT "CINCINNATI."

It is intended for the Pennsylvania Railroad ferry between New York and Jersey City. The hull is entirely of iron; the upper works are of wood, but the boilers and engine are entirely surrounded by an iron casing.

The boat is double-decked, according to the new pattern adopted by the Pennsylvania Railroad Company, thus largely increasing the capacity for passengers.

The *Cincinnati* is 206 ft. long over all; 180 ft. long between perpendiculars; 65 ft. wide over all; 45 ft. molded breadth; 16 ft. 6 in. in depth.

In her machinery the company has followed the example first set on the Hoboken Ferry in the *Bergen*, and has substituted double screws for the side wheels heretofore in use. The boat has two four-bladed screws 8 ft. in diameter, one at each end, both being carried on the same shaft. The shaft is driven by two compound engines which can work up to 1,100 H.P. The engines are being built at Newburg, and we hope to give some further description of them hereafter. The *Cincinnati* will be the fifth double-screw ferry-boat on the Hudson.

In this connection it may be noted that the elevated line of the Pennsylvania Railroad and the new station in Jersey City are so far completed that two of the elevated tracks were brought into use May 17. The local trains are now running over these and into the new station, but the through trains will continue to use the old line until the third and fourth tracks on the elevated structure are finished.

The platforms in the new station are elevated above the street level. From them passengers will pass directly upon the upper decks of the ferry-boats. They will not be obliged to descend to the main deck at all, since the company has completed a bridge over West Street in New York, which is on a level with the second deck of the boats.

## Foreign Naval Notes.

### THE ENGLISH 110-TON GUNS.

AFTER many trials and failures it is believed that satisfactory results with the English 110-ton gun have at last been attained. The weapon put on board the *Sans Pareil* in lieu of that which had a curvature and a drooping tendency in its tube has gone through some of its trials without showing evidence of the defects noticed in the other guns. It will be remembered that in the later guns and in this new gun stiffening bands were put on the bores or muzzles, and in this new gun the stiffening process has gone a step further. Nine of these guns have now been made. Six are in the service, two each on the *Benbow*, *Victoria*, and *Sans Pareil*. Some of them have a slight drooping tendency in the muzzle, but this, it is thought, does not affect their efficiency.

### CHILIAN TORPEDO EXPERIENCE.

The destruction of the insurgent iron-clad *Blanco Encalada* by a torpedo does not seem, from the latest accounts—which are still incomplete—to afford much ground for boasting by torpedo advocates. While the ship was sunk by a Whitehead torpedo, it appears that she was taken unawares and was entirely unprotected, no torpedo-nettings nor other methods of defense being used. Even in this unguarded state it was only the seventh torpedo which reached her, six having been sent out previously, all failing to reach the mark. Indeed, one of them went far astray, and blew up part of a dock. Of course it is not easy to decide from partial accounts, but the incident seems to show that, while a torpedo is formidable when it does strike the mark, it can hardly be considered a reliable weapon yet.

### THE ENGLISH NAVAL EXHIBITION.

The Naval Exhibition recently opened in London seems, from all accounts received, to be very successful. Apart from the historic interest attaching to the memorials of the *Victory* and other old-time war-ships, there is a large collection of guns and other modern naval appliances, showing the latest methods and the gradual steps by which improvements have been made and the present development reached.

### THE CANET GUN.

The accompanying illustrations, from *Le Yacht*, show a 32-cm. (12.6-in.) Canet gun built for the Japanese coast defense ship *Itsukushima*—which was illustrated and described in the JOURNAL for February last, page 83—and recently tested at La Seyne, France. This gun is a built-up gun of the Canet type, which has been very favorably received in Europe, and has a length of 40 calibers, the total length of the piece being 12.80 m. (42 ft.). In the illustrations fig. 1 shows the gun on its temporary mount ready for trial; fig. 2 shows it loaded on railroad trucks for removal.

As will be seen from fig. 2 the gun has no trunnions, but is held by the teeth or toothed grooves formed in the lower part of the outside hoop. The powder chamber is larger than the bore proper, and the rifling is progressive, with a final inclination which experience has shown to be best adapted to give the projectile the speed of rotation needed to secure stability and directness of flight. The breech mechanism is of the screw type, with interrupted threads.

The test of this gun consisted of 20 shots, with charges varying from 264 to 562 lbs. of powder and projectiles varying from 762 to 1,033 lbs. in weight. The highest result obtained was

with a charge of 562 lbs. of powder and a projectile weighing 988 lbs. The muzzle velocity was 2,308 ft. per second; the calculated penetration in wrought-iron plate at the muzzle was

the arc $d\ h$, cutting the line $B\ A$ extended in $h$ and $C\ A$ in $d$. Then from $C$ as a center, with a radius $C\ d$, draw the arc $d\ f$ intersecting $C\ B$ at $f$. From $B$ as a center and a radius $B\ f$

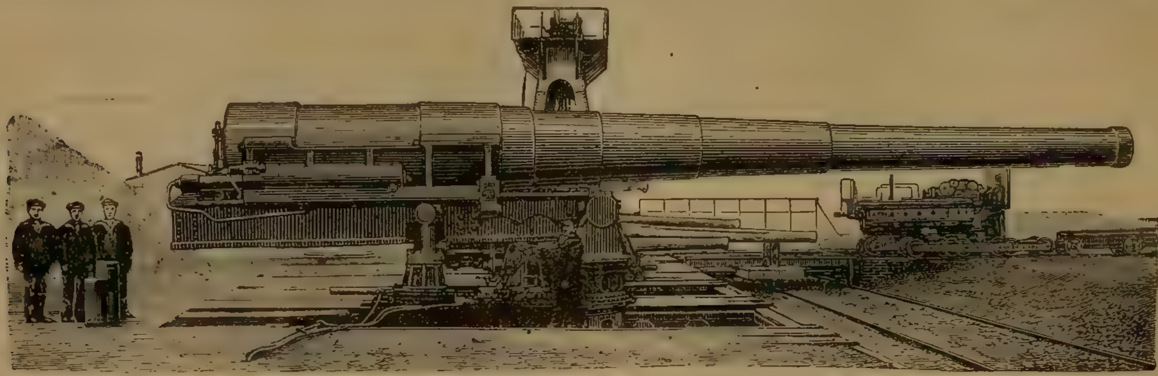


Fig. 1.

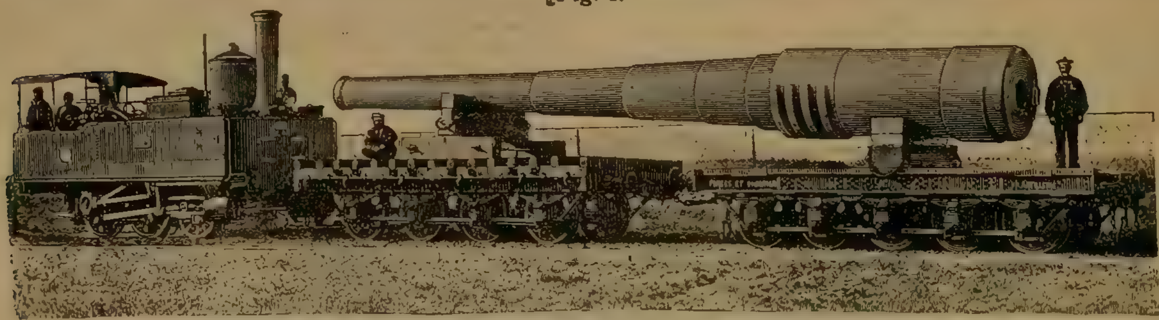


Fig. 2.

THE CANET 32-CENTIMETER GUN.

45.28 in., or at 2,500 m. (8,200 ft.) it was 35.83 in. The gun was in excellent condition after the tests.

This gun was made by the Société des Forges et Chantiers at Havre; its total weight is 145,464 lbs., a little over 72½ tons. It will be mounted in a turret of special construction, and handled by hydraulic machinery.

The French papers consider these results excellent, and claim that the Canet gun has shown itself to be a more powerful weapon than the Armstrong or the Krupp guns of greater weight.

## THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.



(*Continued from page* 231.)

### CHAPTER XI.—(*Continued.*)*

### AN OVAL.

Problem 78. *To construct an oval or egg-shaped figure, fig.* 255.

If $A\ B$ is the width or minor axis of the figure, bisect it at $E$, and from $E$ as a center, with a radius $A\ E$ equal to one-half of $A\ B$, draw the circle $A\ C\ B\ F$, and draw a perpendicular $C\ E\ D$ to $A\ B$. From $A$ and $B$ draw lines through $F$ and produce them indefinitely. From $A$ and $B$, with a radius $A\ B$, draw arcs $A\ G$ and $B\ H$ cutting $B\ F$ and $A\ F$ extended at $G$ and $H$. From $F$ as a center, with a radius $F\ G$, describe the arc $G\ D\ H$ to meet the arcs $A\ G$ and $B\ H$, which will complete the oval.†

### CAM.

Problem 79. *To draw a three-centered cam, fig* 256.

Let $A\ B$ and $C$ be the three centers. Through these points draw the lines $A\ B$, $B\ C$ and $C\ A$, and extend them indefinitely beyond the centers. Then from $A$, with any radius, as $A\ d$, draw

draw $f\ i$; from $A$ as a center and $A\ i$ as a radius draw $i\ e$; from $C$, with a radius $C\ e$, draw $e\ g$, and from $B$ as a center and

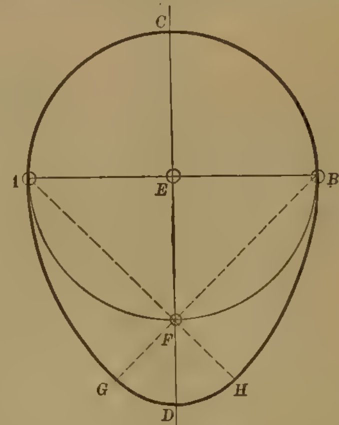



Fig. 255.

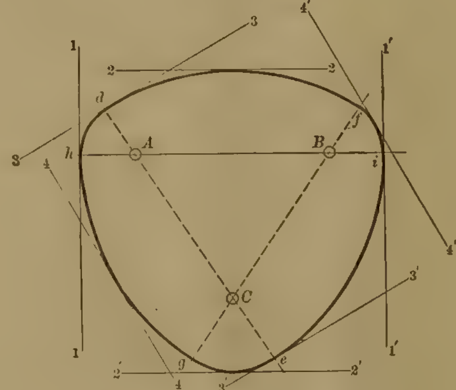



Fig. 256.

$B\ g$ as a radius, draw $g\ h$, which will complete the outline of the cam. The positions of the centers $A$, $B$ and $C$ will be de-

* Attention is called to an error in fig. 252, published last month. The figures in the fourth ordinate were engraved .81603; they should be .86603.

† From "Linear Drawing," by Ellis A. Davidson.

termined by the circumstances for which the cam is used. Such a cam has the property that any two parallel lines drawn tangent to it, as 1 1, 1′ 1′; 2 2, 2′ 2′; 3 3, 3′ 3′ or 4 4, 4′ 4′ will always be the same distance apart.

### THE PARABOLA.

A parabola is a curve of which any point is equally distant from a fixed point, called its *focus*, and from a given straight

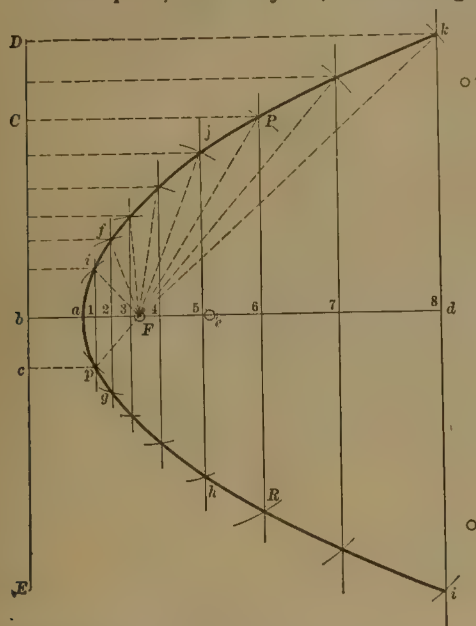


Fig. 257.

line called the *directrix*. Thus in fig. 257 if *F* be the fixed point and *D E* the given line, then the distance *P C* of any point, as *P* in the curve from *D E*, will be equal to its distance *P F* from the focus *F*, and *p F*, the distance of *p* from the focus, is equal to *p c*, and *a*, the *vertex* of the curve, is at an equal dis-

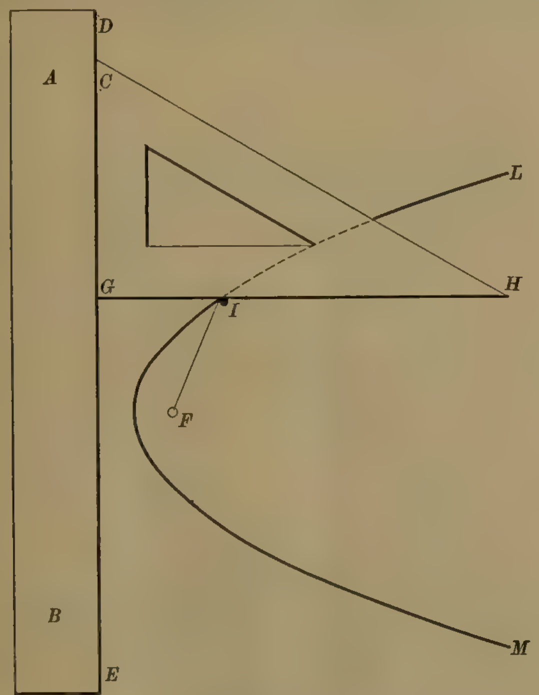


Fig. 258.

tance from *F* and *b*. Consequently the vertex *a* is always midway between the focus and directrix.

A straight line, as *P R* or *k i*, drawn across the figure at right angles to the axis is a *double ordinate*, and either half, as *d k* or *P* 6, is an *ordinate*. A line *a d* drawn through the focus and middle of the curve is called the *axis* or an *abscissa*. A parabola is an open curve—that is, its two extremities never meet, no matter how far they are extended.

The properties of the parabola, which have been explained, afford an easy method of describing it mechanically, and we have

PROBLEM 80. *To draw a parabola when the directrix D E, fig.* 258, *and the focus F are given.*

Place a straight edge, *A B*, so that its edge coincides with *D E*, and let *C G H* be a right-angled triangle or square, one side *C G* of which bears against the straight edge on the side *D E*. Take a thread, the length of which is equal to the side *G H* of the triangle, and attach one end at *H* and the other at the focus *F*. Place a pencil *I* against the thread and the triangle, so as to draw the thread tight. Then if the side *C G* be moved along the line *D E* the pencil will describe a parabola, of which *F* is the focus and *D E* the directrix; for the distance *F I* will be equal to *I G*, for every position of the ruler.*

PROBLEM 81. *To lay off a parabola when the directrix D E, fig.* 257, *and the focus F are given.*

Through the focus *F* draw a line *b d* perpendicular to the directrix *D E*. This is the *axis* of the curve. Draw lines parallel to *D E* and perpendicular to the axis through any points, as 1, 2, 3, 4, etc. These points should be nearer together next to the apex *a* than they are toward the open end of the figure, but their exact position is not important. With the focus *F* as a center and the distance 1 *b*, of the point 1 from the directrix, as a radius, describe arcs cutting the vertical line passing through 1 at *i* and *p*. The intersections *i* and *p* of the arcs with the vertical will be points in the curve. Proceed in the same way for each of the other points 2, 3, 4, etc. Thus with a radius 6 *b* and from *F* describe arcs cutting the vertical line which passes through 6 at *P* and *R*, which will give two more points in the curve. When as many points as may be required are laid down in this way, the curve may be drawn by making a template for the portion lying on one side of the axis, or a close approximation to the true curve may be drawn with compasses by finding by trial a center *e* on the axis from which the portion *f a g* can be drawn. Other centers *m* and *n* can be found in the same way, from which the parts *f j* and *g h* can be described, and the remaining parts *j k* and *h i* can be drawn from centers outside of the figure.

PROBLEM 82. *To lay off a parabola when the length A B, fig.* 259, *of its axis and that of its greatest double ordinate* 8′ *M are given.*

*First Method.*—Through *A*, the vertex of the parabola, draw 8 *A N* perpendicular to its axis *A B*. Through 8′ and *M*, the

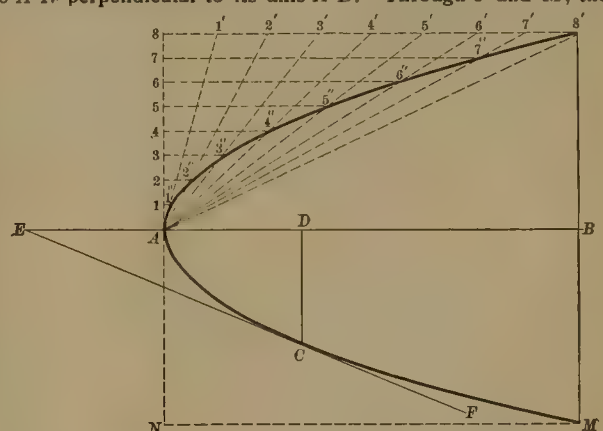


Fig. 259.

ends of the double ordinate, draw 8 8′ and *N M* parallel to *A B*, thus forming a rectangle 8 8′ *M N*, whose sides are respectively equal to the axis and double ordinate. Divide the ordinate 8 *A* into any number of equal parts and the side 8 8′ into the same number of equal parts. From the vertex *A* draw lines *A* 1′, *A* 2′, *A* 3′, etc., to the points of division on 8 8′. From the points of division, 1, 2, 3, etc., on 8 *A* draw lines parallel to *A B* and intersecting *A* 1′, *A* 2′, *A* 3′, etc., at 1″, 2″, 3″, etc. These intersections will be points in the curve.

*Second Method.*—Let *A B*, fig. 260, be equal to the length of the axis, and *L M* be a double ordinate. Extend *A B* and make *A C* = *A B*. From *L* and *M* draw lines *L C* and *M C* to *C*. Divide the sides *L C* and *M C* into any number of equal parts *C* 1, 1 2, 2 3, etc., and draw the lines 1 1′, 2 2′, 3 3′, 4 4′ 5 5′, 6 6′, and 7 7′. The lines will be tangents to the parabola, which may then be drawn so as to touch each of these lines.

PROBLEM 83. *To lay off a parabola with ordinates.*

Let *A B*, fig. 261, be the axis and *C B* an ordinate of a parabola. Divide the axis or abscissa *A B* into eight equal parts,

* Davies's "Analytical Geometry."

and draw ordinates from the points of division perpendicular to $A B$, as shown above $A B$. Multiply the length of $C B$ by the numbers on the ordinates above the axis and lay off the distances thus obtained on the ordinates from $A B$. The points

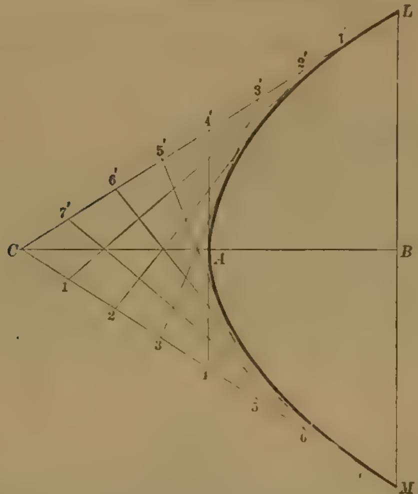


Fig. 260.

Fig 261.

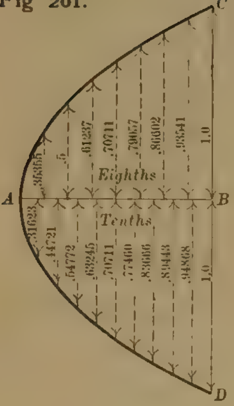
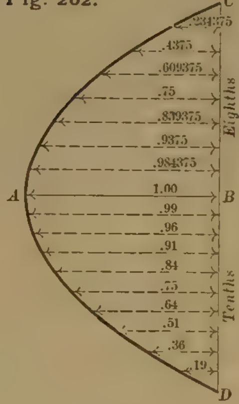


Fig. 262.



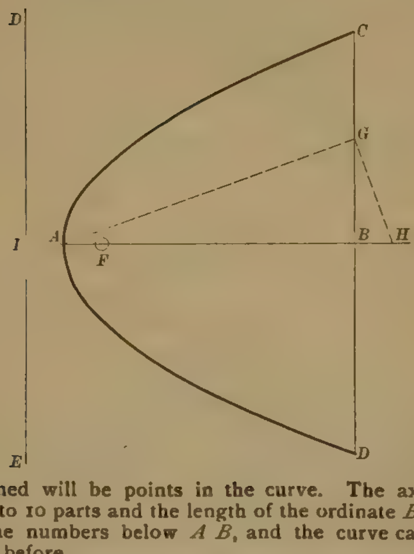


Fig 263.

thus obtained will be points in the curve. The axis may be divided into 10 parts and the length of the ordinate $B D$ multiplied by the numbers below $A B$, and the curve can then be laid off as before.

PROBLEM 84. *To construct a parabolic curve by another method.*

Divide the ordinate $C B$, fig. 262, into eight equal parts, and draw perpendiculars to it through the points of division; the length of these perpendiculars will be determined by multiplying the length of the axis $A B$ by the respective number on each horizontal line above $A B$ in fig. 262. The ordinate $B D$ may be divided into tenths and the length of $A B$ multiplied by the numbers on the horizontal lines below $A B$, and the parabola laid off as described in the preceding problem.*

* The two preceding methods of laying out a parabola are taken from Molesworth's "Pocket-Book of Engineering Formulæ."

PROBLEM 85. *To draw a tangent to a parabola at any point.*

Let $C$, fig. 259, be the point. From $C$ draw $C D$ perpendicular to the axis $A B$. Extend $B A$ to the left and make $E A$ equal to $A D$. A line drawn through $E$ and $C$ will be tangent to the parabola at the point $C$.

PROBLEM 86. *To find the focus and the directrix of a parabola, the axis and an ordinate being given.*

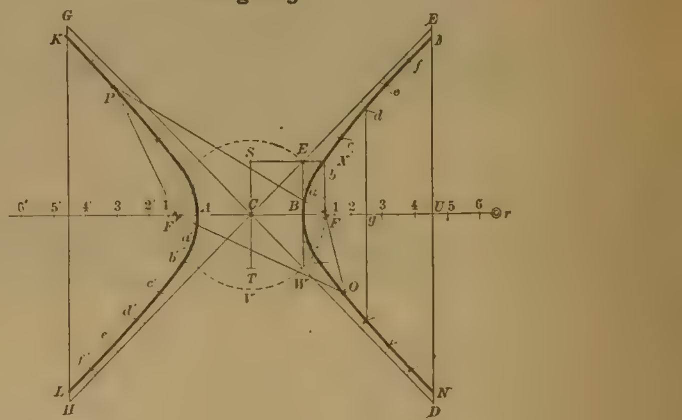
Let $A B$, fig. 263, be the axis and $C B$ an ordinate. Bisect $C B$ at $G$, and from $A$ draw $A G$. Through $G$ draw $G H$ perpendicular to $A G$ and intersecting $A B$ extended in $H$. From $A$ lay off $A F = B H$; then will $F$ be the focus of the parabola. From $A$ lay off $A I =$ to $A F$, and draw $D E$ through $I$ perpendicular to $I B$; then will $D E$ be the directrix.

## THE HYPERBOLA.

If a cone, $D C E$, fig. 264, of which $E D$ is the base, is cut by a plane $J B$ parallel with but not through its axis $Q C$ and perpendicular to its base, the outline of the section thus obtained will be an open curve called a *hyperbola*, and shown by $N B M$, fig. 265. If two cones $D C E$ and $C G H$, fig. 264, are placed so that their apexes join, and if their axes, $Q C$ and $C R$, are in the same straight line and they are cut by the same plane, $J B S A I$, parallel with $Q C R$ the sections thus obtained will form two hyperbolas, $N B M$ and $L A K$, as shown in fig. 265, which are called *branches* of the hyperbola. $A$ and $B$ are the *vertices* of the curves, and the line $A B$, the distance between the vertices, is the *transverse axis*. This is the same as $A B$ in fig. 264, and has been defined as that part of the axis which if continued would join an opposite cone.

The *conjugate axis* $S T$ is a line drawn through the middle of

Fig. 265.



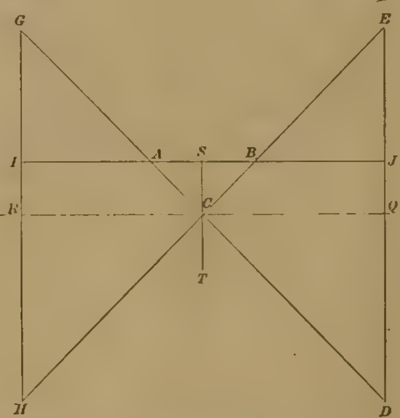


Fig. 264.

the tranverse axis and at right angles to it. It is equal to twice the distance $S C$, fig. 264, of the intesecting plane $I J$, from the axis of the cone from which the hyperbola is produced.

$F F'$, fig. 264, are the *foci* of the two curves, and $C$ midway between $A$ and $B$ is called the *center* of the curve.

The nature of a hyperbola is such that the *difference* of the distances of any point in the curve, from the foci, is always the same, and is equal to the transverse axis $A B$. Thus if from the point $O$ we draw lines $O F$ and $O F'$ to the foci $F$ and $F'$, then the difference of the length of these lines will be equal to $A B$; or if from the point $P$ similar lines $P F$ and $P F'$ be drawn, their difference will also be equal to $A B$.

PROBLEM 87. *Having the transverse and conjugate axes, to find the foci of an hyperbola.*

Let $A B$, fig. 265, be the transverse axis of two branches of

an hyperbola. The ends of the axis will coincide with the vertices of the two curves. From $A$ erect $E\ B$, a perpendicular to $A\ B$, and make it equal to half the conjugate axis, or to the distance $S\ C$, fig. 264, of the intersecting plane from the axis of the cone. Then from $C$, fig. 265, the middle of $A\ B$ as a center and with $C\ E$ as a radius describe a circle $F\ E\ F'\ V\ F'$ cutting $A\ B$ extended at $F$ and $F'$, which will be the foci of the hyperbola.

PROBLEM 88. *The transverse and conjugate axes being given, to lay off an hyperbola.*

Draw $A\ B$, fig. 265, equal to the transverse axis. Find the foci $F\ F'$, as explained in the preceding problem. From $F$ and $F'$ lay off any number of points 1, 2, 3, etc., 1′, 2′, 3′, etc., at equal distances from $F$ and $F'$ respectively. Then with radii $A$ 1, $A$ 2, $A$ 3, etc., and from the foci as centers describe arcs cutting each other at $a$, $b$, $c$, etc., and $a'$, $b'$, $c'$, etc. These will give points in the curve through which it may be traced.

PROBLEM 89. *To draw a hyperbola when its length $B\ C$, fig. 266, its breadth $D\ E$ and transverse axis $A\ B$ are given.*

Construct the parallelogram $D\ E\ F\ G$ and subdivide its upper and lower sides, $G\ D$ and $F\ E$, and each of the ordinates $D\ C$ and $C\ E$ into the same number of equal parts 1, 2, 3, etc., and 1′, 2′, 3′, etc. From the points 1, 2, 3, etc., draw lines to $A$, and from 1′, 2′, 3′, etc., draw lines to $B$ which will cut each other. Their respective points of intersection will be points in the curve, through which it may be traced.

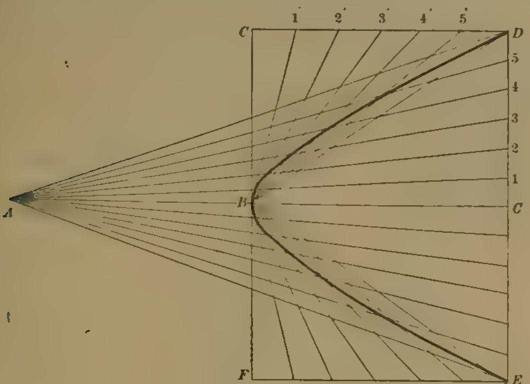



Fig. 266.

THE CYCLOID.

A *cycloid* is a curve which is described by any point in the circumference of a wheel rolling on a straight line. Thus let $A$, fig. 267, be a circle or wheel and 0–16 a straight line equal in length to the circumference of the wheel. In rolling from 0 to 16 a point 0 in the circumference of the wheel would move in the path 0, 1‴, 2‴, 3‴ 5‴, 6‴–16, and if a pencil be held in contact with the wheel while it is rolled from 0 to 16 it will describe the curve 0, 1‴, 2‴, 3‴, 4‴, 5‴–16.

The circle $A$ is called the *generating circle*, and the point 0 in the circle which describes the cycloid is the *generator*. The straight line 0–16 on which the circle rolls is the *director* and 8‴ 8 is the *axis* of the cycloid.

PROBLEM 90. *To lay off a cycloid mechanically for a wheel of any diameter.*

Ascertain by calculation or from a table of diameters and circumferences the length of the circumference of the generating circle. Then lay off a straight line 0–16, whose length is equal to the circumference. Divide the latter and the straight line into any number of equal parts 1, 2, 3, etc., and 1′, 2′, 3′, etc. Place the wheel so that the point marked 0 in its circumference will coincide with 0 in the straight line, and mark the point on the paper. Then roll the wheel toward the right and make the point marked 1′ on the wheel to coincide with 1 on the straight line, and again mark the position of 0′ at 1‴. Proceed in this way, making each of the points 2′, 3′, etc., in the circumference of the wheel coincide with 2, 3, etc., on the straight line, and for each position of the wheel mark the position of 0′ at 2‴, 3‴, 4‴, etc. The marks 1‴, 2‴, 3‴, etc., thus laid down will be points in the cycloid.

PROBLEM 91. *To lay off a cycloid with instruments for a wheel of any diameter.*

Ascertain as before the circumference of the wheel, and draw a straight line 0–16 equal in length to the circumference, and subdivide them both as described. Draw the generating circle $A$ on the perpendicular 8′ 0 and tangent to 0–16. Through the center 0 of $A$ draw a horizontal line $A$–16″ parallel to 0–16. From the points of division 0, 1, 2, 3, etc., erect perpendiculars to 0–16 intersecting $A$–16″. The point 0 will be the beginning of the cycloid. From 1″ as a center and with the radius of the generating circle describe an arc 1 1‴ tangent to 0–16. Take with a pair of dividers a chord 0 1′ from the generating circle, and set off this distance 1 1‴ from 1 on the arc. The point thus laid down will be a point in the cycloid. Proceed in a

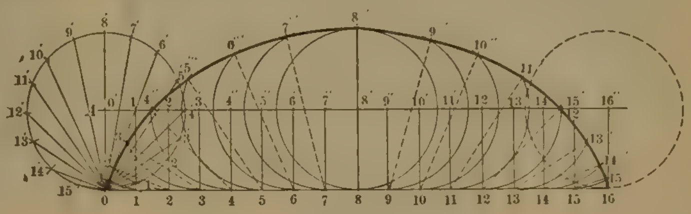


Fig. 267.

similar way, and from 2″ as a center draw an arc 2 2‴, and with a chord 0 2′ lay off from 2 on the arc 2 2‴ the point 2‴, which will be another point in the cycloid. Continuing in the same way draw arcs from each of the points 3‴–16‴ and lay off successive points 3‴–16‴ through which the cycloid may then be drawn.

THE EPICYCLOID.

If the generating circle $A$, fig. 268, rolls on the circumference of another circle 0–16, instead of on a straight line, the curve described by a point 0 in the circumference of the generating circle will be an *epicycloid*. The one which is stationary is called the *fundamental circle*. If the generating circle rolls on the exterior of the fundamental circle the curve described is called an *exterior epicycloid*. If it rolls on the inside, as indicated in fig. 269, it is called an *interior epicycloid* or *hypocloid*.

PROBLEM 92. *To describe an exterior epicycloid mechanically.*

Ascertain as before the circumference of the generating circle and also of the fundamental circle. Then multiply 360° by the former and divide by the latter. This will give the number of degrees in the circumference of the fundamental circle, which will be equal in length to that of the generating circle. From $B$, the center of the former, lay off the angle 0 $B$ 16, which has been ascertained by the calculation. Draw the arc 0–16, which will then be equal to the circumference of $A$. Subdivide the circumference of $A$ as before, and divide 0–16 into an equal number of divisions. From $B$ as a center draw the arc 0″–16″ through $A$, the center of the generating circle, and then draw

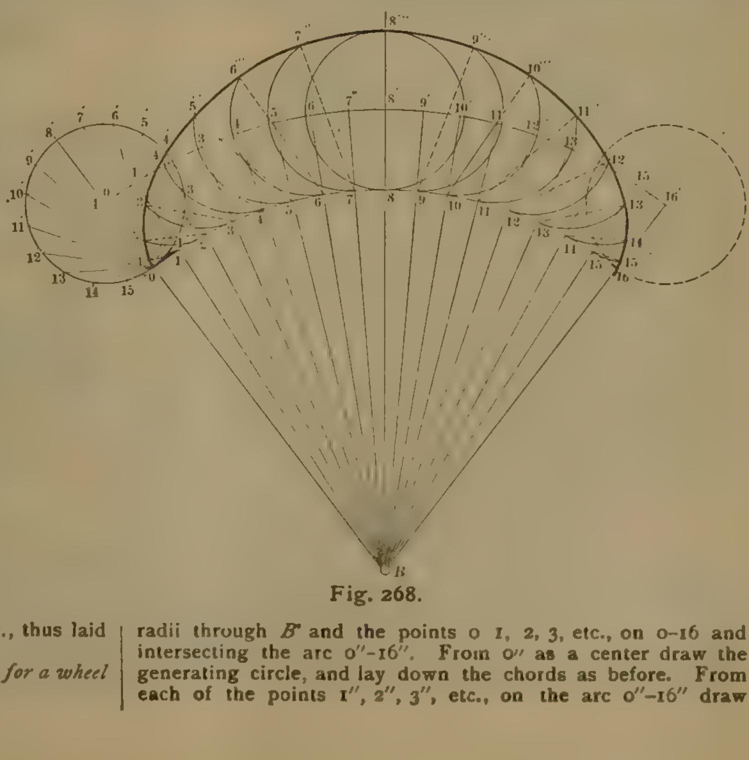


Fig. 268.

radii through $B$ and the points 0 1, 2, 3, etc., on 0–16 and intersecting the arc 0″–16″. From 0″ as a center draw the generating circle, and lay down the chords as before. From each of the points 1″, 2″, 3″, etc., on the arc 0″–16″ draw

arcs 1 1‴, 2 2‴, 3 3‴ as in the preceding problem, and with chords 0 1′, 0 2′, 0 3′, etc., lay off points on the arcs which will be points in the required curve.

PROBLEM 93. *To lay off an interior epicycloid.*

Draw the arc 0–16, fig. 269, of the fundamental circle and the generating circle *A* on the inside as represented. Subdivide the circle and the arc as in the preceding problem, and lay off

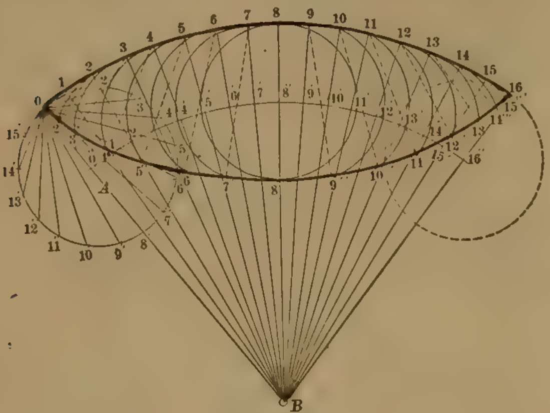


Fig. 269.

the points of the curve with chords 0 1′, 0 2′, 0 3′, etc., on arcs drawn on the inside of 0–16. The method of doing this will be clear from the diagram and the elucidation of the preceding problems. When the diameter of the generating circle is equal to half that of the fundamental circle, the epicycloid becomes a straight line, being in fact a diameter of the larger circle.

(TO BE CONTINUED.)

## Canadian Notes.

A NEW work which is being urged upon the Government of the Dominion of Canada is the construction of the proposed Trent Valley Canal, which is to connect Georgian Bay with Lake Ontario, thereby giving Canada an inside line to the upper lakes entirely within its own territory. The length of this waterway will be about 195 miles, but a considerable portion of this is covered by lake and river navigation, so that less than 60 miles of canal will have to be excavated. Should it be built, vessels coming from Lake Superior, Lake Huron, or Lake Michigan can avoid going through the Detroit River and Lake Erie entirely. The line is one which must have suggested itself to any one who has ever examined a map of the lakes. It is understood that the government approves of the project, but is not prepared to begin construction at once on account of the present financial conditions.

IT is stated that work on the new tunnel under the Detroit River, at Detroit, is to begun shortly on the Canadian side, a charter having been obtained for the company in Canada. The surveys were completed some time ago for this work. The total length, including the approaches, will be a little over 12,000 ft., of which 2,100 ft. will be in an open cutting on the Canada side of the river and 1,500 ft. an open cut on the Detroit side, leaving the actual length of the tunnel about 8,400 ft. It is proposed to make the tunnel large enough for a double track, the cross-section being circular and 27 ft. inside diameter. The method of working to be adopted will be the same as that used in excavating the Grand Trunk tunnel, at Port Huron. The preliminary surveys and borings show that little or no rock will be encountered, the bed of the river at that point being entirely of clay. The bottom of the tunnel at the lowest point will be about 75 ft. below the surface of the river. It is thought that it will require about three years to build the tunnel; the projectors expect to have it open to all railroads which may desire to use it.

## Naval Observatory Positions.

THE Civil Service Commission will require, in order to fill vacancies in the Naval Observatory after July 1, a list of eligibles for the following-named places: One electrician at a compensation of $1,500 per annum, one photographer at $1,200 per annum, one assistant librarian at $1,200 per annum, and three computers at $1,200 each per annum.

The examinations for the different grades will be as follows: For electrician the examination will be both theoretical and practical, covering the subjects of electric batteries, currents, resistance, and measurements, together with the construction and maintenance of electric-lighting plants, and the methods of transmitting power by electric currents. For photographer the examination will cover, first, the ordinary photographic manipulations, together with the different processes used in the art; second, the character of the necessary optical apparatus, together with the application of photography to astronomical work. The assistant librarian examination will include the translation into English of short paragraphs of scientific German, French, Latin, Italian, and Spanish writings, the bibliography of scientific, especially astronomical, literature, modern library methods, and systems of classification. The examination for computers will include algebra, geometry, logarithms, trigonometry, and elementary astronomy.

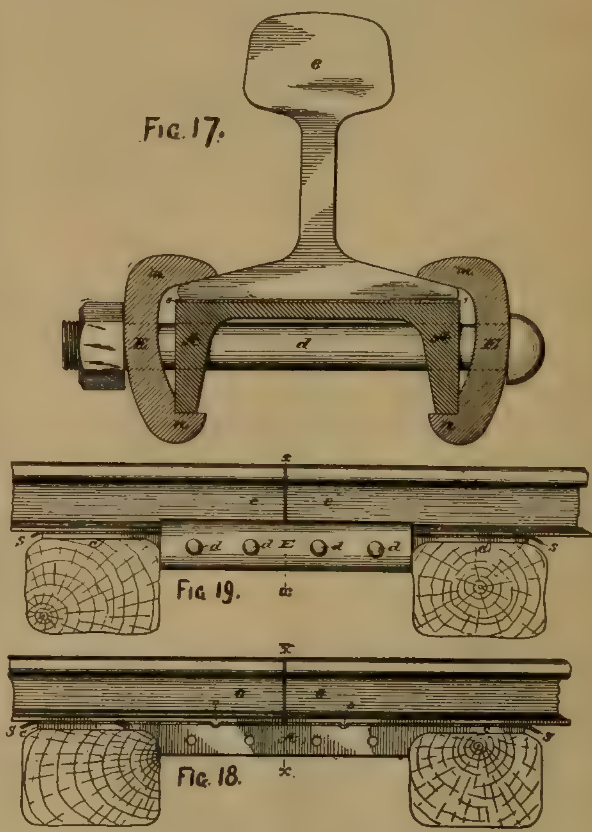
These examinations may be taken at any date and place named in the schedule of the commission. A special date will be fixed at Washington as soon as a sufficient number of applications is received to justify it.

## Recent Patents.

### McGIEHAN'S RAIL-JOINT.

A NEW form of rail-joint is covered by patent No. 431,611, issued to Isaac S. McGiehan, of New York. This is shown in figs. 17–19, fig. 17 being a cross section, fig. 18 a side view with the clamps removed, fig. 19 an elevation of the joint complete.

In constructing this joint a piece of channel-beam iron is taken, as shown in cross-section at *A*, fig. 17, the requisite size and the ends of its sides cut out, as shown at *c c*, figs. 18 and 19, so that it will rest upon two cross-ties, one end on each




McGIEHAN'S RAIL-JOINT.

tie, as shown in figs. 18 and 19, with the sides of the channel extending downward between the ties to form a truss and at the same time providing a flat upper surface for the rail ends to rest upon. Two clamps are then provided, as *E E*, figs. 18 and 19, formed, as shown in cross-section, with two jaws, one running along its top edge and the other running along its lower edge, as shown at *m* and *n*. The jaw *n* fits under and engages with the lower side of the channel-bridge *A*, and the

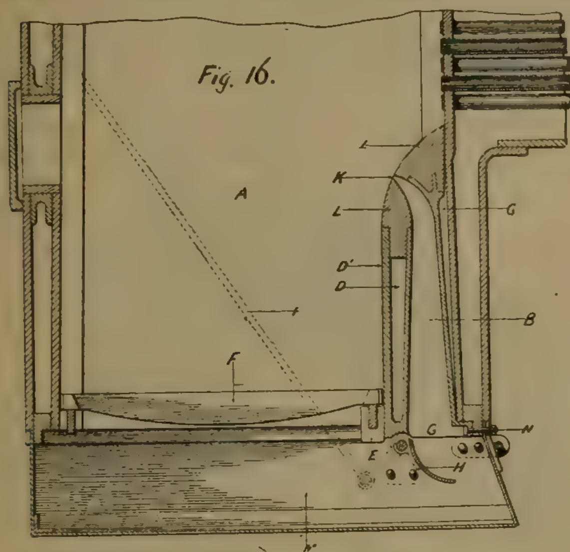
jaw *m* passes over the rail-base. After these are in place, the bolts *d* are passed through the clamps and sides of the channel-beam bridge, and when these are drawn together the jaws *m* slide up on the rail-base until the rail is finally seated upon the channel-beam bridge, and by utilizing the bevel of the rail-base as a wedge for the jaws *m* to slide over, together with the bolts *d*, sufficient clamping force is obtained to practically convert the whole into a solid structure, so that the joint is quite as strong as any other part of the rail. There is placed on top of the channel-beam bridge a piece of chemically prepared or tar paper *s*, which acts as a cushion for the rail to rest upon and destroys the metal contact between the rails and the bridge, and it also prevents the parts from rusting together.

The lower jaws *n* of the clamps *E* do not slide under the bridge when the bolt is tightened, as is usual with such joints. The lower jaw *n* is provided with a shoulder, which strikes the outside of the bridge and prevents it from sliding further under, thus throwing the entire movement to the upper jaw, which is shaped so as to utilize the bevel of the rail-base to slide over, and thereby produce a more substantial and rigid grip than could be otherwise obtained.

In order to prevent the rails from creeping, when necessary four depressions are provided in the corners or edges of the channel-beam bridge *A*, as shown at *o o*, fig. 18, and the edge of the flange of the rail is bent down to fit into these depressions, so that when the clamps *E* are in position it would be impossible for the ends of the rail to draw out.

CHUBB'S SMOKE CONSUMER.

MR. WILLIAM J. CHUBB, of London, England, has patented the arrangement of fire-box represented in fig. 16, which consists of a tuyere or funnel-shaped passage *G*, which may extend entirely across the fire-box or furnace-chamber, and by which air is drawn into the tuyere from below the fire-bars and discharged




CHUBB'S SMOKE CONSUMER.

through one or more narrow mouths in such wise as to mingle with the unconsumed gases and smoke that are making their escape from the furnace, whereby the desired more perfect combustion is effected. This tuyere *B* is made of metal, is surrounded with air spaces, and is so formed that one or more blocks *L* of fire-brick, fire-clay, or other similar material of the required shape can be held in suitable seatings in the top of the casting, to protect it from the action of the fire. A door *H* is placed at the bottom *G* of the tuyere, by which the admission of air to the fire-box may be regulated.

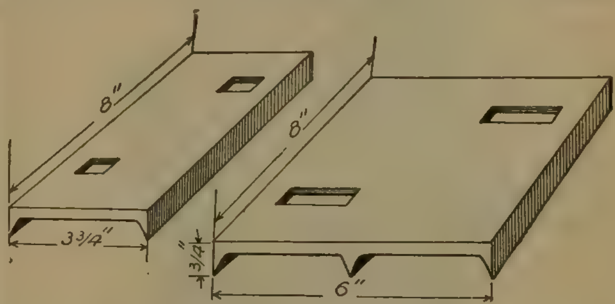
# Manufactures.

## A Quadruple-Expansion Engine.

THE new steam tug *Dorothy* recently completed at the yard of the Newport News Ship Building Company, and intended for very heavy work—towing car-floats in New York Harbor—is of steel, 90 ft. long over all, 18 ft. beam, and 8½ ft. draft. The chief peculiarity of the *Dorothy* is that she has a quadruple-expansion engine, designed by Mr. Horace See. This engine is of the double-crank tandem type, with cylinders 9½ in., 13½ in., 18¾ in., and 26 in. in diameter, and 22 in. stroke. The cranks are placed at right angles with each other, and the valve gear is provided with cut-off attachments. The upper cylinders are so arranged that the pistons of the lower cylinders can be examined without difficulty. The engine is intended to work at a pressure of 180 lbs. The propeller is of iron 7 ft. in diameter. Steam is furnished by a steam boiler of the cylindrical return tubular pattern 9 ft. 6 in. in diameter and 10 ft. 6 in. in length.

## Track Appliances.

THE use of tie-plates under the rail for protecting a tie is now very common, and the advantages gained are so substantial that their use is extending. There is also a tendency to use a wider plate than was originally adopted, especially for lines of heavy traffic, and at points where there is unusual strain upon the ties. The wide plate is found to have other advantages

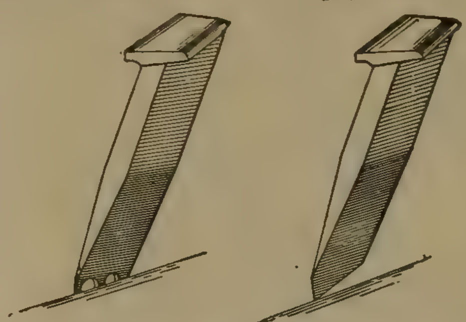



THE SERVISS TIE-PLATE.

besides preserving the tie, such as preventing the canting of the rail, and consequent side rail of the head on curves, and preserving through gauge.

Many forms of tie-plates have been tried, but those having a plain surface have not been altogether successful, having a tendency to work loose and to rattle when the rails are not tightly spiked down. The accompanying illustration shows the Serviss plate, which is provided with flanges which serve the double purpose of sustaining the plate itself and of entering the tie and holding the plate in its place.

The second cut shows the Davies spike, which is of steel with a double head. When driven at an angle, as shown, and in



THE DAVIES LOCK SPIKE.

combination with the tie-plate, these spikes making lock fastenings, it gives great lateral resistance and, it is claimed, a much greater resistance than the use of a rail brace.

## A New Multipolar Motor.

THE latest development in the way of motors is of the multipolar type, is called the Simplex motor, and was recently shown to representative electricians at the company's rooms, in Boston.

It is an invention which seems to reverse the order of things, for, instead of applying the power or current to the center, as in the old types of machinery, the energy is concentrated on the outside or periphery.

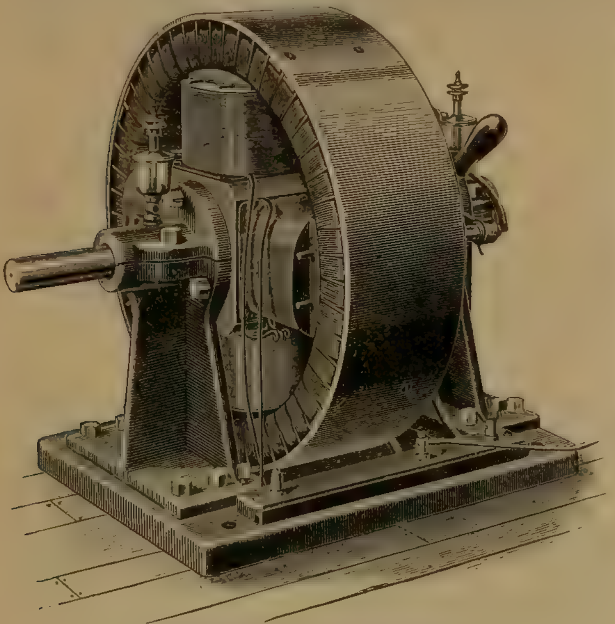
In the matter of construction lies the fundamental rupture between the Simplex and the prevailing type of motors. The location of the field is on the inside, and thus it becomes tenfold more compact, and diminishes the weight to one-fourth that of those now used. It also has the shortest possible magnetic circuit, consequently can be energized with less wire, and naturally less current. The armature being in the form of a ring,

which encircles the field, can be extended to any diameter; thus an enormous initial can be obtained, and the speed of such an armature may be very slow, and the ventilation of coils, being the best possible, there is no liability of "burn-outs," for the armature is always comparatively cool.

This armature, revolving as it does, only from 100 to 700 revolutions per minute instead of from 2,000 to 3,000, proportionately reduces the friction on bearings, and requires less attention to lubrication and replacing worn parts, and further, obviates the noise consequent upon the more rapid machines—a gain in one direction at least, which the public will readily understand and appreciate.

The application of the Simplex motor to vehicles, it is claimed, may be obtained in several ways:

1. Directly, by making the motor a wheel of the vehicle. In this case, all of the benefit of weight is obtained for traction



THE SIMPLEX ELECTRIC MOTOR.

purposes, while but a small part of this weight is carried by the vehicle itself; that is, the motor rests on the rail or ground, according to the use to which it is put.

2. It may be suspended to the vehicle and directly connected to the axle of the same.

3. It may be mounted in the cab of a locomotive, and connected to the axle by means of side rods, as in the steam locomotive, or by belting, the advantages of this method being that the motor is high from the ground, and is thus protected from moisture and dust accumulations, while at the same time every part is open to view and as accessible as if it were stationary or located in the shop.

The first two of these methods involve no loss whatever in the transmission of power, the last-named method only a very slight one. It will thus be seen that there is no limit to the working capacity of this machine, the mechanical construction being capable of enlargement to an unlimited extent without materially increasing its weight, whereas the old types must necessarily be kept within a certain fixed weight.

Several of these motors have been ordered by well-known companies, and it is said that practical tests will soon be made in service. One of the motors is shown in the accompanying illustration.

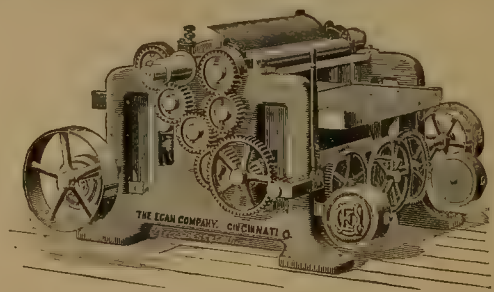
## Smoothing Planers for Wood-Work.

In recent years a great advance has been made in planing machinery for giving a surface to all kinds of wood. The accompanying cut shows one of the latest developments in this direction, a heavy planer and smoother. The one shown is a 30-in. size, but the tool is made in six sizes, to take in from 24 to 42 in. wide.

The means of adjusting the bed is claimed as the best known, making it solid and free from vibration, having more support beneath it than can be obtained in any other way.

The feed consists of four powerfully geared feed-rolls of large diameter, and the fluted or front feed-roll is driven by expansion gearing, making it impossible for the roll to lift out of gear when taking a heavy cut, making a feed that can be relied upon as being first-class in every particular. The feed-rolls are weighted on an improved principle, the weights being adjustable to give more or less pressure as desired. There are two speeds to the feed, and it is stated that this machine will do smoother work at its fastest feed than has heretofore been attained on any other smoothing planer at a much slower speed.

The cylinder is four-sided, so as to use either two or four knives, as may be desired. It is double belted, and the feed is

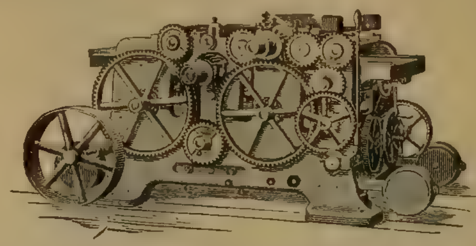



No. 4 EXTRA HEAVY PLANER AND SMOOTHER.

run directly from it. There are pressure-bars on each side of the cylinder, arranged on a new principle, to work to the circle of the head, thus preventing all tearing out of wavy-grained or knotty stuff, either narrow or wide, or clipping of ends, which is so common with many smoothing planers.

One of the greatest advantages of this machine, especially in the wide sizes, is that the stock can be run diagonally under the cylinder, which is far better than running a cylinder in a diagonal position, as it permits straight belts being run to the cylinder, and the planing of short stuff. It is specially adapted for planing framed stock where straight and cross-grained wood is built up, and which heretofore has given car-builders trouble on account of their not being able to plane this particular kind of wood.

The second cut shows a double-cylinder planer and smoother, which is the same machine, but provided with two cylinders,



No. 9 DOUBLE CYLINDER PLANER AND SMOOTHER.

for planing with the under cylinder as smooth as with the upper; this machine is simple to adjust and to operate. It has been very successful, and will do a large amount of perfect work.

This machine will be found a valuable one for car-builders and others who have stock to dress on both sides, especially wide or hard wood. They are made by the Egan Company, whose works are at Nos. 194–214 West Front Street in Cincinnati.

## A New Steam Heating System.

A new system for the continuous heating of trains by steam is now being introduced by the Morton Safety Heating Company of Baltimore, which not only promises well, but has also shown good results so far as tested. The advantages claimed for this system are summed up as follows:

1. The heat is stored in an earthenware tube, enclosed in an iron pipe; steam is applied for five or ten minutes only, and sufficient heat is stored to keep the car comfortable for several hours.

2. It is the only system by which a regular temperature can be maintained at all times and in all weather.

3. When at night, the locomotive is detached, and the train is left standing out of doors for ten or twelve hours without steam, the train will be from 35° to 45° next morning. With any live steam or hot-water system the train would be cold in one hour.

4. It is safe; there being no steam or hot water remaining in our pipes, there is no danger of scalding, in case of accident to the train.

5. It is *economical;* because steam need only be taken from the locomotive when it is stationary, or running down grade, and our material will not freeze in the coldest weather.

6. It is so simple that any one can be instructed to manage it in a few minutes.

The first claim is supported by an accidental test on the Grand Trunk, where, on March 11, the engine of a passenger train heated by this system broke down near Island Pond, and a freight engine was attached; the train was without steam for five hours, and on arrival at Montreal the thermometer registered 65° in the cars. As to the second, on January 29 last, on the Intercolonial Railway, a train was run between Halifax, N. S., and St. John, N. B., 275 miles, and a regular temperature of from 70° to 72° maintained the entire distance, by application of steam for five minutes each hour.

During the past winter this system was tested practically by daily use on the Norfolk & Western; the Chicago, St. Paul, Minneapolis & Omaha; the Richmond, Fredericksburg & Potomac; the Canadian Pacific; the Grand Trunk and the Intercolonial roads.

It is well adapted to street cars also, and has been in use on the Baltimore City and Baltimore Traction lines; in Dover, N. H., and on the West End Company's lines in Boston.

The Morton Company has its headquarters at No. 106 East Saratoga Street, Baltimore. The officers of the company are E. G. Kenly, General Manager, and Eugene Carrington, General Superintendent.

## General Notes.

THE special pipe-joint grease made by the Joseph Dixon Crucible Company has given excellent results when used for mud-plugs in locomotive boilers and similar purposes, and its use is extending.

THE Mason Regulator Company, Boston, has acquired the exclusive right to make and sell the piston-throw indicator patented by Mr. Frank Robinson, of Bangor, Master Mechanic of the Maine Central Railroad. The device is very simple, and shows a car inspector at once the condition of the air-brake pistons. It is a convenient device and one much needed.

THE New York office of the Taylor Iron Works is now in the new Central Building at Liberty and West streets. This building is becoming a center for railroad business.

THE Johnson Railroad Signal Company has removed its New York office to No. 47 Broadway.

THE works of the Cleveland City Forge & Iron Company contain 23 hammers in all, of which seven are upright and the others are helve hammers. The heaviest of these hammers has a 10 ton head with an 8-ft. stroke. Among the achievements of these works are the manufacture of a shaft 4 ft. in diameter on the bearings; plate bending rolls 32 in. in diameter and weighing 64,740 lbs. each, and a triple-expansion crank shaft weighing 60,810 lbs. The machine shop connected with these works is equipped with unusually heavy tools for handling the largest masses of metal coming from the hammers. One of their lathes, built in Scotland, will take in a shaft 60 ft. in length.

THE Ball & Wood Company has bought the recent patents and inventions of Frank H. Ball, and will engage in the manufacture of high-speed, automatic cut-off engines. The new company is building extensive shops at Elizabethport, N. J., which will be equipped with the best tools, with a view to building the improved Ball engine. Mr. Thomas C. Wood is President, and Charles R. Vincent Secretary and Treasurer.

THE Carlisle Manufacturing Company, Carlisle, Pa., is about to erect a brick building 300 ft. in length, to replace the frog shop, which was recently destroyed by fire. The shop is now occupying temporary quarters.

THE Bethlehem Iron Company at Bethlehem, Pa., has now a Yale & Towne hydraulic testing machine which has a capacity of 300,000 lbs. This machine is chiefly used in testing the armor-plates and gun forgings which the company is now making for the United States Government.

The business offices of this company, with that of the President, Mr. R. B. Linderman, have recently been removed from their old location in the works to the new building of the Lehigh Valley Railroad in Bethlehem.

AN addition to the general office building of the Lehigh Valley Railroad at South Bethlehem, Pa., has just been finished, nearly doubling its size. The company now has offices of ample size, very handsomely and conveniently arranged. The engineering offices now located at Wilkes-Barre are being removed to South Bethlehem, and also the Paymaster's office and those of the Coal Department.

THE shops of Tippett & Wood, Philipsburg, N. J., are filling a large contract for ore chutes and dock equipment for the Sagua Iron Company in Cuba; that company is largely owned by the Thomas Iron Company, of Hokendauqua, Pa. Tippett & Wood are also building a stand-pipe for the water-works at Henderson, N. C., and one for Winter Harbor on Grindstone Neck in Maine.

THE Allentown Rolling Mill Company, Allentown, Pa., has added to its extensive works a spike mill with a capacity of 20 tons a day, which started up May 11. In this mill new patented machinery is in use; it is in charge of a gentleman who was long engaged in the business in Brazil, Ind. The company has nearly completed a new factory for its switch and signal department, which is in charge of Mr. Frederick S. Guerber.

THE Philadelphia Bridge Works of Cofrode & Saylor have recently received the following important orders: For the Philadelphia & Reading Railroad, 20 girder and truss bridges on the Port Reading Extension, from near Bound Brook to Kill Von Kull; for the New York Central Railroad, three large plate girder bridges on the Rome, Watertown & Ogdensburg Division; for the Central Railroad of New Jersey, three bridges, two of which are for six tracks; for the Pennsylvania Railroad, two bridges at Trenton, N. J.; also, a large iron machine shop to be built at Jersey City.

THE latest transatlantic fast steamer is the *Fürst Bismarck* of the Hamburg-American Company's line. The new ship is 500 ft. long, 57 ft. 6 in. beam, and 38 ft. deep. There are twin screws, each driven by a triple-expansion engine capable of working up to 8,000 H.P. There are nine double-ended boilers, and also an additional boiler on the upper deck for running the pumps and auxiliary engines.

THE factory and office of Joel H. Woodman & Company, manufacturers of car seats, panels, veneering, etc., has been removed to Fifteenth and Clinton streets, Hoboken, N. J. The new buildings are large, covering an area of 200 × 200 ft., and have facilities for doing a great amount of work. This firm has also recently bought out the New York business of Foster & Petersen; that firm will be reorganized as Petersen Brothers, and removed to Portsmouth, N. H.

THE steamboat *Rhode Island*, of the Providence & Stonington Steamship Company, has recently been supplied with a new engine by the Morgan Iron Works in New York. She now has a compound beam engine, with high-pressure cylinder 64 in. diameter and 7 ft. stroke; low-pressure cylinder 84 in. diameter and 12 ft. stroke. The low-pressure cylinder is connected to the forward end of the beam; the high-pressure cylinder to the after part of the beam, in front of the connecting rod. The paddle-wheels are of the ordinary type and 34 ft. in diameter.

Two new steel ferry-boats are under construction at the Marvel yard in Newburg, N. Y. for the Hoboken Land & Improvement Company, and the first of them, the *Bremen*, was launched May 12, and towed to New York to receive her engines. The hulls of these boats are 220 ft. long, 40 ft. beam, and 17 ft. deep. They will have a screw at each end, both screws being on the same shaft and driven by compound engine, having two high-pressure cylinders, 20 in. diameter, and two low-pressure, 36 in., all being 28 in. stroke.

THE new steel steamer *E. C. Pope*, launched from the Wyandotte yard of the Detroit Dry Dock Company on May 2, is, it is claimed, the largest freight carrier on the lakes. The general dimensions are: Length over all, 334 ft. 6 in.; length of keel, 314 ft.; beam, 42 ft.; depth of hold, 24 ft. The boat will have a propeller 13 ft. 2 in. in diameter, driven by a triple-expansion engine, with cylinders 22 in., 35 in., and 56 in. in diameter and 44 in. stroke. Two steel cylindrical boilers, each 14 ft. 3 in. by 11 ft. 6 in., will furnish the power at a working pressure of 160 lbs. The hold is divided into eight separate water-tight compartments, which may contain 950 tons of water ballast. The boat is fitted with a Worthington ballast pump, a Providence steam windlass and steam capstans furnished by the American Ship Windlass Company, Williamson steam-steering gear, and all the modern appurtenances of a first-class steamer. Three pole masts, without sails, are carried.

THE Rhode Island Locomotive Works in Providence have recently completed 5 engines for the New York, New Haven & Hartford, 2 moguls for the Fort Worth & Rio Grande, and have orders for 21 others, including 4 moguls for the Maine Central, 3 switch engines for the Old Colony, 5 for the Mil-

waukee, Lake Shore & Western, 6 for the Wabash, and 3 for the Mexican Central.

DURING the month of April the Schenectady Locomotive Works turned out 33 engines, including six 18 × 24 ten-wheel passenger, three 17 × 24 six-wheel shifting engines for the Chicago, St. Paul, Minneapolis & Omaha; two 20 × 24 consolidation engines for the Chicago & Eastern Illinois; six 18 × 24 ten-wheel passenger, four 19 × 24 ten-wheel freight, and five 17 × 24 six-wheel shifting engines for the Chicago & Northwestern; four 18 × 24 six-wheel shifting engines for the Fitchburg Railroad; one 17 × 24 Forney engine for the Erie & Wyoming Valley, and two 16 × 20 narrow gauge 12-wheel freight engines.

THE Brooks Locomotive Works, Dunkirk, N. Y., have recently received orders for 10 freight engines for the Wisconsin Central Railroad and for 20 locomotives for the Cleveland, Cincinnati, Chicago & St. Louis Railroad.

THE Rogers Locomotive Works are building 18 locomotives for the Nashville, Chattanooga & St. Louis and 8 heavy engines for the Columbus & Hocking Valley. They have also received an order for 10 ten-wheel freight engines for the Houston & Texas Central.

THE Pittsburgh Locomotive Works have received orders from the Wheeling & Lake Erie Railroad for three yard engines and six ten-wheel freight engines for that road.

## The Smillie Car Coupler.

THE effect of the adoption of the Master Car Builders' type of couplers has been to stimulate inventors all over the country, and has led them to make many improvements in the details of couplers of the vertical plane type. The illustrations which are given herewith represent a form of coupler which has been

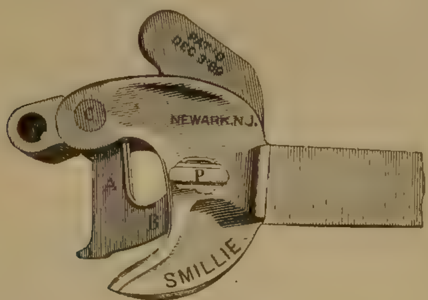



Fig. 1.

evolved through the stimulus referred to. As will be seen from the engravings, it is made on what are called the Master Car Builders' "lines"—that is, the contour of the parts which engage with each other are made of the form recommended by the Master Car Builders' Association.

Fig. 1 is a perspective plan and fig. 2 a similar view, with the head of the coupler shown in section. The knuckle *A* is of a Z shape, and in fig. 1 is shown in the position it occupies when open, and in fig. 2 it is shown closed. When the locking pin *P* is withdrawn the knuckle can be swung into the open

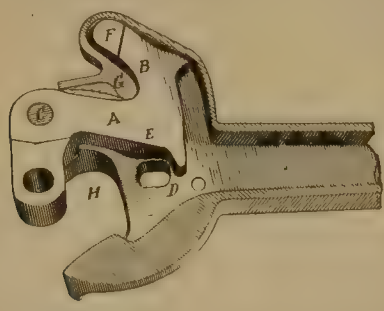



Fig. 2.

position shown in fig. 1. The inside arm *B* of the knuckle then comes below the pin and supports it. When the knuckle is completely open the pin rests on the end of the arm *B* in a step *F*. The weight of the locking pin and its connections thus holds the knuckle in its open position for coupling. When two open couplers come together the force of the blow raises the locking pin out of the depression *F*, the knuckle is turned on the pivot pin *C*, and the arm *B* is pushed back from under the pin into the position shown in fig. 2. In this position it no longer supports the locking-pin, which then falls 6 in. into the hole *D*, and the knuckle bears against the pin at *E*, and is thus securely locked. At the same time the arm *B* is held in the recess made to receive it in the coupler-head. It is there enclosed by a solid wall of metal, so that with the locking and pivot pins it forms a triple combination to resist the pulling force on the couplers. Even if the pivot pin *C* should be broken or removed, the knuckle would be held in its position by the locking pin, the arm *B* and the metal in front of it.

From fig. 2 it will be seen that, when coupled to another car, the knuckle bears against the locking pin at *E*. The reaction of this strain is resisted by the pivot pin *C*, or by shoulders *H* on the back of the knuckle. If the pivot pin *C* was broken or removed, the shoulders referred to and the metal at *C* would still be sufficient to resist the pulling strain on the coupler, thus forming a double lock, as was shown by the following tests, which were made by Mr. N. O. Olsen, on a Fairbanks testing machine, in April of this year. The knuckles were steel from two different makers, the draw heads malleable iron:

| | | | | | |
|---|---|---|---|---|---|
| 1. | Tension, | with pivot pins, | knuckle | breaking at | 111,600 lbs. |
| 2. | " | " " " | " | " " | 119,400 " |
| 3. | " | without pivot pins, | " | " " | 106,560 " |
| 4. | " | with " " | drawhead | " " | 139,640 " |
| 5. | " | without " " | knuckle | " " | 135,360 " |

Test No. 3 was with coupling locked without pivot pins and pulled as in service, both knuckles having been used in 1st and 2d tests, broke as above. Test No. 4 was with pivot pins, the drawhead breaking at 139,640 lbs. Test No. 5 was without pivot pins, the knuckle breaking at 135,360 lbs.

The double lock was in as good condition after the tests as before.

The locking pin must be lifted 6 in. to unlock, therefore the coupler will not unlock by any jolt of the train in motion.

The unlocking device consists of the usual shaft and lever arms, carried in bearings attached to the end of the car, but instead of a chain to lift the pin a clevis is used, which holds up the pin when the knuckle is set not to couple.

This coupler is made by the Smillie Coupler and Manufacturing Company, at 91 Clay Street, Newark, N. J. The New York office is at 52 Broadway.

## The Baltimore Cable Railroad.

WORK on the cable road of the Baltimore Traction Company is practically completed. The only work now being done on the tracks is on South Howard Street, where the operations of the Belt Railroad have caused the street bed to sink, throwing the cable track out of level.

The gripmen who are to manage the cars are taking lessons daily, and workmen are going over the line and the machinery looking for defects. Experimental trips are being made daily, and the management expect to have the road in full operation by June 10.

Ground was broken for the road March 24, 1890. As it stands to-day the road is, according to the claims of its officials, the best in the world. It has about 6 miles of double track laid upon iron yokes placed 5 ft. apart, and weighing 500 lbs. each. The road is strong enough to carry the heaviest train that is run over the Pennsylvania Railroad. The cable cars weigh 15,000 lbs., each being 10,000 lbs. heavier than the horse cars. They run on two trucks of four wheels each.

Over 7,000,000 bricks were used in the construction of the power-houses. Each house contains two 500 H.P. Corliss engines, with groove wheels 26 ft. in diameter.

Thirty-two cotton ropes 2½ in. in diameter form the belt for the wheels.

The entire work was done by the United States Construction Company, of Philadelphia. Much of the machinery was made by the Robert Poole & Son Company, and Bartlett, Hayward & Company, of Baltimore.

The road runs the entire length of the city, from Druid Hill Park west to Patterson Park east.

## PERSONALS.

WILLIAM A. HAMILL has been appointed Railroad Commissioner of Colorado.

S. C. WEISKOPF has been appointed Engineer and Eastern Agent of the Keystone Bridge Company, of Pittsburgh.

THOMAS COGSWELL has been appointed Railroad Commissioner of New Hampshire, in place of JOHN MITCHELL, resigned.

GEORGE M. BASFORD, late Assistant Engineer of Tests of

the Union Pacific, is now Signal Engineer of the Chicago, Milwaukee & St. Paul.

E. H. KEATING, late of Halifax, N. S., has been appointed City Engineer of Duluth, Minn. He has had much experience in wharf and dock construction.

THE new Railroad Commission of Texas consists of ex-Senator JOHN H. REAGAN, who needs no introduction; JUDGE W. P. MCLEAN, a well-known lawyer, and L. L. FOSTER.

HON. JOHN H. B. LATROBE, for many years connected with the Baltimore & Ohio Railroad as a Civil Engineer, celebrated his 88th birthday at his residence in Baltimore, May 4.

C. H. QUEREAU has been appointed Engineer of Tests of the Chicago, Burlington & Quincy Railroad, succeeding F. W. SARGENT, who has resigned. Mr. Quereau has been Assistant Engineer for some time.

WALTER G. OAKMAN has been chosen Vice-President of the Central Railroad Company of New Jersey, succeeding JOSEPH S. HARRIS, who recently resigned in order to devote his time entirely to the business of the Lehigh Coal & Navigation Company. Mr. Oakman was recently connected with the Richmond & Danville Railroad.

SAMUEL M. ROWE has resigned his position as Chief Engineer of the Atlantic & Pacific, and is now engaged in building a narrow-gauge line running from Coolidge, N. M., southward. Mr. Rowe has been on the Atlantic & Pacific for some time, and had charge of the construction of the cantilever bridge over the Colorado at Red Rock.

REAR-ADMIRAL D. L. BRAINE, who has for some time past been in command of the New York Navy Yard, has been relieved from that position and placed upon the retired list, as he has reached the limit of age prescribed by law for active service. His successor in command of the New York Yard will be CAPTAIN HENRY ERBEN.

WILLIAM H. BURR, recently General Manager of the Phœnix Bridge Company, has severed his connection with that Company, and has purchased an interest in the business of Sooysmith & Company. From June 1 Mr. Burr is Vice-President of that Company, which is now as heretofore conducting the business of contracting and superintending engineers for bridges, substructures, foundations, docks, tunnels, and other works.

## OBITUARY.

GEORGE R. CAMPBELL, President of the Campbell Frog & Crossing Works, died in Bucyrus, O., about May 1. Previous to engaging in the manufacturing business, Mr. Campbell was for a number of years Roadmaster of the Toledo & Ohio Central.

SAMUEL M. CUMMINGS, who died in Boston, May 6, aged 75 years, was for many years Master Mechanic of the Pittsburgh, Fort Wayne & Chicago Railroad, and was widely known as an active and efficient officer. He retired from active business several years ago, and had since lived in Boston.

FEW men can look back over 50 years of railroad service, but one of them was JOHN WALTON, who died recently in Elizabeth, N. J., aged 80 years. He entered the service of the old New Jersey Railroad in 1834, as a workman on the construction of the road between Elizabeth and New Brunswick. He remained on the road after it was finished, and about 1844 was made Section Master. He had charge of the section between Elizabeth and Rahway until he ended his 50th year of work in 1884, when the Pennsylvania Railroad Company retired him on a pension.

MAJOR PEYTON RANDOLPH, who died in Washington, April 22, was a civil engineer by profession, and his first work was on the location of the Richmond & Danville Railroad. He was also for a time on the Ohio & Mississippi. He served during the war in the Confederate Army, and after the close of the war was engaged on the Elizabeth, Lexington & Big Sandy road. In 1873 he was appointed Chief Engineer of the Virginia Midland and remained on that road nine years, for four of them being General Superintendent. In 1882 he was made Assistant General Manager of the Richmond & Danville, and in 1888 General Manager. Major Randolph was prominent and active in the transformation of the General Time Convention in the American Railway Association, and was one of the leaders in bringing about the change.

PETER WARD, who died in Newburg, N. Y., May 10, aged 63 years, was for many years a civil engineer and contractor. As a contractor he was well known, having laid hundreds of miles of road in various parts of the country, from the Atlantic to the Pacific coast. His last enterprise is not yet completed, that of the Zig-Zag Tunnel on the Ontario & Western Railroad. Mr. Ward was active in local affairs, and had served as Mayor of Newburg and in the New York State Senate.

LAWSON VALENTINE died May 5, at his residence in Mountainville, N. Y., aged 63 years. He was born in Cambridge, Mass., and in 1847 began his career in the paint and varnish business, in which he afterward became so well known, as an apprentice in Boston, with the firm of Wadsworth, Nye & Company. In 1852 he formed a partnership under the name of Stimson, Valentine & Company, for the purpose of manufacturing varnish, and this was the beginning of the large business which he afterward built up. The firm continued in business unchanged until 1867, when the style was changed to Valentine & Company. In 1882 this Company was incorporated, with Mr. Lawson Valentine for President. In the same year he retired from that office, however, and in 1886 started a new Company, the Lawson Valentine Company, of which he was President and active manager up to the time of his death. In his long business career he met with varied success, but succeeded fully in his general object, which was the establishment of the manufacture of varnish in this country, and it is chiefly due to his efforts that the imported varnishes were practically driven from the market.

Mr. Valentine during his whole business life was much interested in journalistic enterprises. He was the founder of the *Hub*, the oldest and best known of the carriage trade journals, and took an active interest in its conduct. In 1877 he became interested in the *Christian Union*, and was shortly afterward made President of that Company. He was also President of the Rural Publishing Company, which has issued the *Rural New Yorker* and the *American Garden*. He was a frequent contributor to his various publications, and also to the paper named *Varnish*, which he himself issued for the purpose of forwarding his business interests. In addition to this he was a silent partner in the publishing house of Houghton, Mifflin & Company, of Boston. Besides all of these business occupations he was an active member of the New York Chamber of Commerce, the American Geographical Society, and of a number of other societies and clubs. Mr. Valentine had many friends, and his death will be widely regretted.

PROFESSOR JULIUS ERASMUS HILGARD, formerly Superintendent of the United States Coast Survey, died in Washington, May 8, after a long illness. He was born in Zweibrücken, Bavaria, in 1825, and came with his parents to America 10 years later. His father was a lawyer, with strong tastes for literature and science, and he educated his sons so carefully that all became prominent in the scientific world. Julius was studying engineering at Philadelphia when, in his twentieth year, he attracted the attention of the late A. D. Bache, Superintendent of the United States Coast Survey. Professor Bache persuaded the young man to become his assistant, and for 40 years afterward Mr. Hilgard was in the Coast Survey Bureau, becoming the Superintendent in 1881, but resigning four years later. His relations with Professor Bache were those of a personal friend as well as assistant. The immense increase of work of the Bureau, occasioned by demands for information about our coast line by naval vessels and transports during the civil war, compelled Professor Bache to give up active work, his mind failing. Mr. Hilgard, who might have had the place, remained Assistant in charge of the office, and did his chief's work and his own, so that Mr. Bache might continue to draw his salary. In 1872 Professor Hilgard was a delegate to the International Metric Commission which met at Paris, and was offered the directorship of the International Bureau of Weights and Measures. In the same year he corrected the long accepted difference between the longitude of Paris and Greenwich. Later he superintended the magnetic survey of the United States provided for by a bequest of Professor Bache. He was one of the founders of the National Academy of Sciences, and was a member and once President of the American Association for the Advancement of Science, besides being a member of many other learned bodies. Most of his writings appeared in the publications of the Coast Survey Bureau, but he was known to many as a most lucid speaker on scientific subjects, which gen-

erally are discussed in terms above ordinary comprehension. Personally he was a man of high character, strong friendships, and extreme unselfishness.

### Charles G. Ellis.

The death of Charles G. Ellis, President of the Schenectady Locomotive Works, occurred at Schenectady on May 15. He took a slight cold while out driving two days before, which rapidly developed into pneumonia, which caused his death.

For the following particulars concerning the Schenectady Locomotive Works and Mr. Ellis's connection with them we are indebted to the *Daily Union* of Schenectady :

It was incorporated on June 14, 1851. The first buildings had been erected by citizens of Schenectady three years previous, under the name of the "Schenectady Locomotive Engine Manufactory." A company formed carried on the works one year, but unsuccessfully, when the buildings were closed and remained idle for a year, during which time a part of the personal property was sold for taxes. The whole works were finally sold at one half cost. The purchasers under the sale were John Ellis, Daniel D. Campbell, and Simon C. Groot. New capital was raised, and an organized firm resulted.

In the same year, 1851, Walter McQueen acquired an interest, which he still holds. In February, 1863, John C. Ellis bought out his original partners and obtained full control of the property. The war of the rebellion at that time made a lively demand upon the works for locomotives for government service in the hauling of trains of troops upon military roads at the seat of operations. In consequence the business grew to large dimensions, the force of operatives steadily increased, and the buildings became enlarged and increased. Mr. John Ellis died in 1865. His eldest son, John C. Ellis, then became President of the Locomotive Company. Hon. John C. Ellis died in 1884. Charles G. Ellis had become the President of the company the year before, with Walter McQueen, Vice-President, and Edward Ellis, Treasurer.

The works have been very much extended during late years, and now employ nearly two thousand men. Since the death of his father John Ellis, the son, Charles G. Ellis, as one of three brothers and a half-brother to whom the locomotive works' property descended, has been a very active factor in the management of the industry. He made an exhaustive study of the details of the business, and derived a full and practical acquaintance which ever after became of great assistance to him in his active efforts to advance the enterprise. He took a lively interest in the business, and gave daily attendance and often long hours to the work of managing details outside of the superintendent's duties.

Mr. Ellis served one term in the State Assembly in 1868. He was a constant attendant at the First Presbyterian Church, of which at the time of his death he was one of the trustees. He was also one of the directors of the National Mohawk Bank, and a very useful and serviceable one. Both church and State will thus feel his loss in a community point of view.

He was 48 years of age, and leaves a wife, one daughter, and many friends, not only in the community in which he lived, but wherever he was known.

## PROCEEDINGS OF SOCIETIES.

**Master Mechanics' and Master Car-Builders' Associations.**—In view of some statements which have been made public lately, the following official announcement will be of interest :

"At a joint meeting of the Executive Committees of the Master Car Builders' and Master Mechanics' Associations held in the Murray Hill Hotel, New York, recently, a resolution was unanimously adopted, expressing confidence in the efforts Mr. Walton, Proprietor of the Stockton Hotel, Cape May, is making to accommodate the persons who intend to be present at the conventions. This was done after Mr. Walton had explained in detail his method of assigning rooms and his charges. The committees were satisfied that any person who does not call for a selected room can have room and board for $3 a day."

The proprietor of the Stockton Hotel announces that he will put up a special pavilion on the grounds of the hotel, in which space will be rented to exhibitors at the rate of 25 cents per square foot. Steam can also be supplied to run machinery.

The proprietor of Congress Hall, at Cape May, has issued the following circular : "This hotel will open June 6 for the Conventions of Car Builders and Master Mechanics. The hotel is brick, and will accommodate 500 persons. One thousand feet of piazza, for which there will be no charge for exhibitors. Terms, $3 per day for each person, not obliged to go two in a room. The hotel is two minutes' walk from the Stockton."

**Northwest Railroad Club.**—At the regular meeting, in St. Paul, May 12, Mr. C. A. Seley read a paper on Fuel and the Best Appliances for Lessening Consumption, in which he gave some interesting particulars of tests of locomotives made on the Great Northern Railroad. This paper was discussed by members present.

**Seaboard Road Association.**—This Association was formed at a meeting held in the rooms of the American Society of Civil Engineers in New York, April 28, representatives being present from several of the Eastern States. A number of addresses were made on the necessity of better roads, and it was resolved to organize the Association for the purpose of securing better roads and encouraging the formation of State associations to co-operate with the central society.

The officers chosen were : President, Colonel A. A. Pope, Boston ; Secretary, F. W. Skinner, New York ; Governing Committee, E. P. Carpenter, A. F. Noyes and A. A. Pope, of Massachusetts ; A. J. Coleman, of Rhode Island ; C. L. Burdett, of Connecticut ; J. Bogart, J. R. Dunn, and E. P. North, of New York ; F. A. Dunham and J. Owen, of New Jersey ; A. J. Cassatt, of Pennsylvania.

**American Society of Mechanical Engineers.**—The fifth monthly reunion of the Society was held April 30, in New York. The address of the evening was delivered by Park Benjamin, on the Story of the Beginning of the Science of Electricity. He traced the growth of the science from its first mention in literature, in 1490, to the present time. The lecture was illustrated with lantern slides. Nearly 150 members were present. After the lecture supper was served in the large dining-room.

**American Society of Civil Engineers.**—A regular meeting of the Society was held May 6, President Octave Chanute occupying the chair. After the transaction of routine business, the Secretary read a paper by Julien A. Hall, on Right of Way for Railroads, which was discussed by R. L. Harris, P. F. Brendlinger, C. J. Bates, E. P. North, C. B. Brush, J. F. Crowell, C. E. Emery, and others. The following candidates were announced elected :

*Members :* William Albert Allen, Portland, Me.; Edward Burr, Cascade Locks, Ore.; George Dowman Fitz Hugh, Birmingham, Ala.; Charles Webster Gay, Lynn, Mass.; Robert Giles, Topeka, Kan.; Howard Hill Jackman, Wichita, Kan ; Andrew Dempster Whitton, Philadelphia.

*Associate Members :* Frederik Christian Holberg Arentz, St. Louis, Mo.; William Ashburner Cattell, Long Island City, N. Y.; Harry Frease, Cleveland, O.; Thomas Henry Grant, Red Bank, N. J.; William Dean Janney, Ceredo, W. Va.; Richard Lamb, Norfolk, Va.; Frederick Morley, Ann Arbor, Mich.; Theodore Starrett, Chicago, Ill.; Edmund Coffin Stout, New York ; George Copeland Urquhart, Steubenville, O.; Sigmund von Gemmingen, Richmond, Va.; Edwin Hall Warner, Seattle, Wash.

The Secretary also announced the election of the following candidates by the Board of Direction :

*Associate :* Harry Comer.

*Juniors :* James Berrall, Edward Thomas McConnell, James C. McGuire, William C. Tucker, Frank Walker Wilson.

Notices are given that the annual Convention will be held at Lookout Mountain, Tenn., beginning May 21. On that day there will be morning and afternoon sessions, at which there will be short addresses having special reference to the topography and industries of that region.

On the second day, Friday, May 22, the business meeting will be held, and in the evening President Chanute will deliver his annual address. On Saturday, May 23, the day will be devoted to an excursion by steamer down the Tennessee River and return ; in the evening the annual banquet will be held.

On Monday, April 25, there will be two sessions, and probably an adjournment. After the Convention there will be opportunity for those members who desire it to accept the invitations which have been received to visit Nashville, Birmingham and other points.

A number of papers have been received, and are ready for distribution to those who attend the Convention.

**Engineers' Club of Philadelphia.**—At the regular meeting, April 18, it was ordered that the Directors be authorized to have the Club incorporated.

The tellers reported the following elections: *Active Members:* J. Clarence Ogden, John S. DeHart, Jr., Charles B. Colby, C. Louis E. Amet, Hermann S. Hering, Albert R. Cline, J. Adelbert Patton, William H. Boardman, and Fred C. Dunlap. *Associate Member:* David S. B. Chew.

Mr. Trautwine presented for Captain S. C. McCorkle an illustrated paper on Land-Locked Navigation from Long Island Sound to the Mississippi. The Author stated that he had simply given that portion of the route with which he is most familiar, leaving the distance from Long Island Sound to the St. John's and St. Mary's Rivers to others.

The portion of the route referred to between West Florida and Louisiana has for its initial point the Suwanee River. The exact point of departure depends upon the location of the Florida Ship Canal.

It is variously estimated that the distance from the Suwanee River to St. Mark's is from 70 to 90 miles, the former referring to a direct cut and the latter to a dredged line.

From St. Mark's to the Mississippi there is a water line nearly all the way, but requiring improvement.

The Oclockony and Crooked Rivers require straightening and the removal of sundry bars, which is not supposed to be difficult, and entirely practicable. In St. George's Sound, near Apalachicola, an oyster bar needs to be removed, and then the Apalachicola River is reached with 12 ft. of water on the bar.

The distance from St. Mark's, Fla., to Apalachicola, Fla., by the coast line, is about 61 miles—by the Oclockony and Crooked Rivers, about 10 miles longer.

From the Apalachicola River to the Mississippi the distance is about 400 miles, and it will require about 30 miles, possibly less, of canaling to make land-locked connection between the two rivers.

No attempt has been made to solve engineering difficulties or to make estimates—the route is given and the data furnished for some ambitious engineer to give to the country one of its most important means of coast defense, and to add to the commercial facilities of the whole country. Estimated total distance from the Suwanee to the Mississippi, 560 miles.

Estimated depth of water *en route*, 9 to 12 ft. at mean low water.

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At the regular meeting, May 2, the Secretary presented, for Mr. George R. Ide, a paper descriptive of the Judson Pneumatic System for Street Railroads as constructed and operated at Washington, D. C. This system comprises connected, rotating cylinders lying below and between the rails of the track, and in line therewith, which cylinders are operated by compressed-air engines placed at intervals along the line. The cylinders are mounted in bearings in a conduit, and are engaged or clasped by a gripping mechanism suspended from the bottom of the car. The grip comprises two pairs of disks mounted so as to have their axes turned in an approximately horizontal plane to any desired angle with the axis of the underlying cylinder. When the axes of the disks are parallel with the cylinder axis the car will remain stationary, but when turned to any proper angle therewith the car will be moved. The velocity with which the car is moved depends upon the angle of inclination of the disk axes to the cylinder axis, the speed of the cylinder remaining constant. The speed of the car increases with the angle up to about 60°. With the cylinder in the same direction the car can be run forward, stopped or reversed by the mere change in the inclination of the disk axes, which inclination is under the control of the driver upon the car platform.

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**Civil Engineers' Club of Cleveland.**—A regular meeting was held May 12, President Gobeille in the chair. Mr. John B. Weddell was elected corresponding member. A vote of thanks was extended to Mr. Aug. Mordecai for his donation to the Club of a crayon portrait of Mr. Charles Latimer, now deceased, former President of the Club. The Executive Board was instructed to incorporate the Club under the laws of Ohio.

The President appointed Mr. William T. Blunt as member of the Permanent Committee on International Engineering Congress and Engineering Headquarters in connection with Columbian Exposition of 1893.

Mr. James Ritchie read the paper of the evening, entitled Recent Advancement in Electric Engineering, describing some of the more remarkable discoveries, inventions, and improvements that have been made in this branch of engineering. This was followed by a discussion in which a number of members participated, and the new uses to which electricity has been put were described, as well as many other uses to which it may be put, but which are waiting for the necessary improvements of the electrical engineer before it can be done.

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**Engineers' Society of Western Pennsylvania.**—At the regular meeting, in Pittsburgh, April 21, J. J. Thoresen, Samuel Foster, C. B. Connelly, and J. Atwood were elected members.

Mr. Daniel Stienmetz described the working of the Fales grate; Mr. John A. Brashear exhibited some samples of steel castings made by the Chester Steel Casting Company and by the Reliance Company of Pittsburgh.

Mr. Phineas Barnes then read a paper on Co-operation in Machine Design, which was discussed by members present.

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**Engineers' Club of Cincinnati.**—The regular meeting was held April 16, with 28 members and several visitors present. Four applications for membership were received.

The following question received considerable attention from various members: "On reasonably firm sub-soil, which form of curb is to be preferred in street construction; 5 in. × 14 in. curb on 6 in. concrete with concrete backing to within 5 in. of the top, or 5 in. × 21 in. curb on clay or 2 in. gravel with earth backing, difference in cost being 10 per cent. in favor of the shallow curb?"

Mr. A. Petry read a paper giving a description of the apparatus used and the manner of measuring the quantity of water delivered to the reservoirs by the pumping engines forming a part of the new water-works plant being erected by the city of Covington.

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**Engineering Association of the South.**—The regular monthly meeting was held in Nashville, Tenn., April 9. The death of Mr. H. S. Butler, of Anniston, was announced, and a committee was appointed to prepare a memorial. The memorial on the life of the late Mr. E. Pardon was submitted and approved. Mr. W. W. Perry, of Nashville, was elected a member.

Resolutions were adopted in relation to the meeting of the American Society at Lookout Mountain in May.

Major W. F. Foster, of Nashville, read a paper on the Engineering Profession, treating the subject under three heads: The relation of engineers to one another; their relation to their clients, and their relations to the general public. He advocated greater interest in the welfare and advancement of young engineers, and a spirit of mutual aid and good faith rather than of reserve and criticism. He also dwelt on the important office of engineers as arbitrators between their clients and contractors.

## NOTES AND NEWS.

**The Rose Polytechnic Institute.**—This well-known school is one of those which is especially devoted to the education of civil and mechanical engineers. One of the peculiar features of the Institute is the thorough and extensive shop practice of the students in mechanical engineering. Not only are machines designed and working drawings made, but actual construction is required and is made possible in extensive workshops, the equipment of which has cost over $40,000. H. T. Eddy, the new President, is well known as the Dean of the Faculty of the University of Cincinnati, and a great educator and organizer.

**Nicaragua Canal.**—At the annual meeting of the Maritime Canal Company, of Nicaragua, in New York, May 7, Henry E. Howland was elected a Director in place of the late Frederick Billings. A. B. Darling, Charles C. Glover, of Washington, Franklin Fairbanks, C. Ridgely Goodwin, and Alexander T. Mason were chosen Directors for three years. All of them were re-elected except Mr. Glover, who succeeds Francis A. Stout, resigned.

The officers of the company chosen were: President, Hiram Hitchcock; Vice-President, Charles P. Daly; Secretary and Treasurer, Thomas B. Atkins; Chairman of the Executive Committee, James Roosevelt. The last-named gentleman succeeds Mr. Billings.

President Hitchcock's report showed that since December 1, 1890, much additional work had been done. The total length of breakwater built now exceeds 1,000 ft., and the channel dredged across the Greytown bar is over 150 ft. in width. The canal's right of way for purposes of immediate excavation has been marked out for 11 miles southwest of Greytown, with a width of 486 ft.

The work of excavating the artificial canal proper was actually

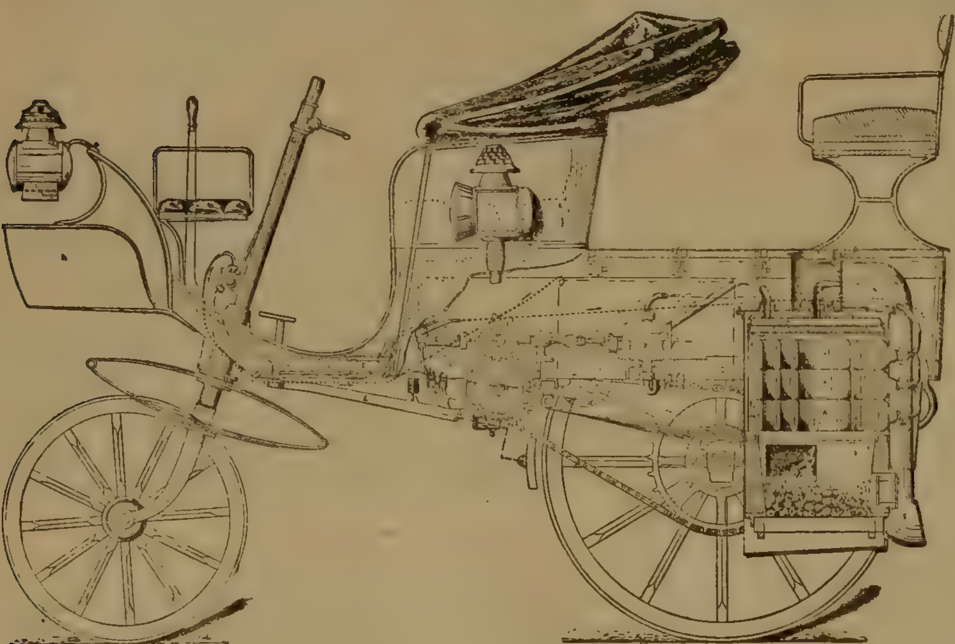
begun on January 1, 1891, and since then the dredgers have advanced about 1,300 ft. from the lagoon, making a channel 150 ft. wide and 20 ft. deep. This work is being done with dredges purchased last summer.

This is a distinct organization from the Construction Company, of which Hon. Warner Miller is President, but practically both companies are united.

**A Steam Carriage.**—The accompanying illustration, from the *Revue Industrielle*, shows a steam carriage invented and built in France by M. Serpollet, for use on common roads. It is a revival of an old idea, which has been attractive to many inventors. As will be seen, there is an upright tubular boiler and a small high-speed engine carried on the rear axle, the driving-shaft and the axle being connected by gearing and a chain. The front axle carries the steering gear. The smoke-stack is so arranged as to throw the smoke, etc., out at the back of the carriage. The cylinder of the engine is 5 in. in diameter and 5 in. stroke, and is arranged to cut off at 55 per cent. of the stroke.

In a recent trial trip of two hours the engine developed 5.3 H.P. indicated, making an average of 257 revolutions per minute. In that time the weight of water vaporized in the boiler was 267 lbs., with a consumption of 46 lbs. of coal.

The carriage shown has tanks and fuel boxes under the seat; they will carry coal enough to run 36 miles and water for 18 miles. Ready for work the carriage weighs 2,755 lbs.; it has carried seven passengers, has attained a speed of 12½ miles an hour, and has ascended a grade of 8 per cent. The longest run yet made has been from Paris to Douai, 143 miles, over a very good road, with sharp grades at several points.



**Lighting the Harlem Tunnel.**—The *Electrical Engineer* says: "The New York Central Railroad has begun experiments with a view to lighting the tunnel.

"The west-side rock-cut tunnel, through which its north-bound local trains run, has been lighted with incandescent electric lamps of about 40 c. p., placed alternately on either side of the track, about 125 ft. apart.

"Reflectors placed on the south side of the lamps prevent the glare of light from reaching the eyes of the engineer or fireman of approaching trains, and throw the light forward on the track.

"The lamps are placed 3½ ft. above the rails, and their light should not interfere in any way with the signal lamps, which are placed much higher.

"It has been alleged, and denied, that the New York Central officials have tampered with the arrangements so as to make it appear that the lighting did more harm than good by blinding the engineers. There is not the slightest reason why these small incandescent lights, properly placed, should have the effect of blurring or rendering useless signal lights."

**Periodicals of the World.**—The *Revue Scientifique* (Paris) estimates that 41,000 periodicals are now published in the world. Of these 24,000 are published in Europe, the leading countries as to number being Germany with 5,500; England and France, each 4,100; Austria-Hungary, 3,500; Italy, 1,400; Spain, 850; Russia, 800, and Switzerland, 450; the remaining 3,300 being divided among Sweden and Norway, Denmark, Portugal, Greece, the Balkan kingdoms, and Turkey.

The United States has 12,500; Canada, 700; Mexico and Central America, 600. The South American republics count up about 2,000 in all.

Japan claims 200 of the 300 periodicals credited to Asia. It seems, however, that this must be an under-estimate, for there are many more than 100 periodicals published in British India, though the number in other Asiatic countries is very small. Africa has 200 journals, the greater number appearing in the British colonies in South Africa, and in Algeria. Australia has 700, and there are a few published in the Pacific islands, Hawaii having 3 of them.

As to language, English has a decided lead, no less than 19,000 journals appearing in that language. German comes next with 7,500, and French third with 6,800. There are 1,800 in Spanish and 1,400 in Italian.

"Of making of many books there is no end." The Wise King would have some reason for his complaint had he lived to this day.

**Toughening Cast-Iron.**—The Manchester correspondent of the *Engineer* describes a very simple method of toughening cast-iron, recently introduced by Mr. A. Jepson, of Arcade Chambers, Manchester, and which was, in the first place, designed chiefly for the bottom and side plates of ordinary ovens; it has since been further developed for application to a variety of other purposes, and some brief notice of the invention will be of interest. The foundation of the patent is that with certain proportions of thickness of wrought iron to certain proportions of thickness to cast-iron a complete fusion or amalgamation of the metal takes place without altering the consistency of the wrought iron and without chilling the cast-iron, and the process is applicable to almost all cast-iron in which lightness and special strength are required. For instance, a piece of cast-iron ½ in. thick, with a core of 27 wire gauge wrought iron perforated sheet placed in the center, is increased in strength six times, and the plate is equal to cast-iron of fully an inch in thickness. Recently the process has been applied to the casting of large drain pipes to which great damage is frequently done in transit. By inserting a core of thin wrought iron into the castings of these pipes, they have been so strengthened that the liability to fracture in carriage has been reduced to a minimum. Another application of the process is for toughening the ash plates in front of boilers on board ship; these plates frequently getting nearly red hot, are consequently subject to fracture upon coming in contact with water; but by the adoption of Mr. Jepson's toughening process this danger has been entirely overcome. In the manufacture of oven plates it has been found that a thin sheet of wrought iron of 27 wire gauge put inside a ½ in. plate so toughens the iron as to render the plate practically unbreakable by fire. The process has also been applied to the manufacture of the bottom plate in hydraulic presses, where the severe strain frequently causes these plates to snap in two. The process of manufacture of such plates is to place two cores of 24 wire gauge sheets every 2 in. apart through a 6 in. plate, thus forming five layers, and the additional strength thus secured is sufficient to render the press bottom unbreakable. The thin sheets used for inserting in the castings are, it is added, very fine steel or wrought iron with a thin coating of tin; and as these can be blocked into any shape, they can be readily covered by the metal in almost every form of ordinary casting.

**Submarine Cannon.**—The *Turin Gazette* describes some experiments made in the Lake of Como with a submarine cannon, invented by a son of the engineer Toselli. The gun

was discharged at a depth of 100 meters, and the shell passed through an equal thickness of water in 10 seconds. The advantage consists in the gun being invisible to an enemy; and the object is, not to pierce an ironclad as a torpedo does, but to sink the hostile vessel, owing to the commotion produced by the explosion. A larger cannon is being constructed, under the inventor's direction, to be tested at Spezzia in the presence of naval and military authorities.

**The Cost of British Drink.**—The *English Mechanic* says: "It is appalling to find that the Drink Bill of 1890 amounts to £139,495,470—an increase of £7,282,194 over the sum of the previous year, all common sense and medical science notwithstanding. It is not our business, says the *Lancet*, to moralize on this expenditure. To us it means so much cirrhosis, Bright's disease, gout, rheumatism, insanity, etc., disabling employment, taking the pleasure out of the lives of families, and bread out of the mouths of children. The Drink Bill for last year is larger than for any year but that of 1878, when it was more than 142 millions of pounds."

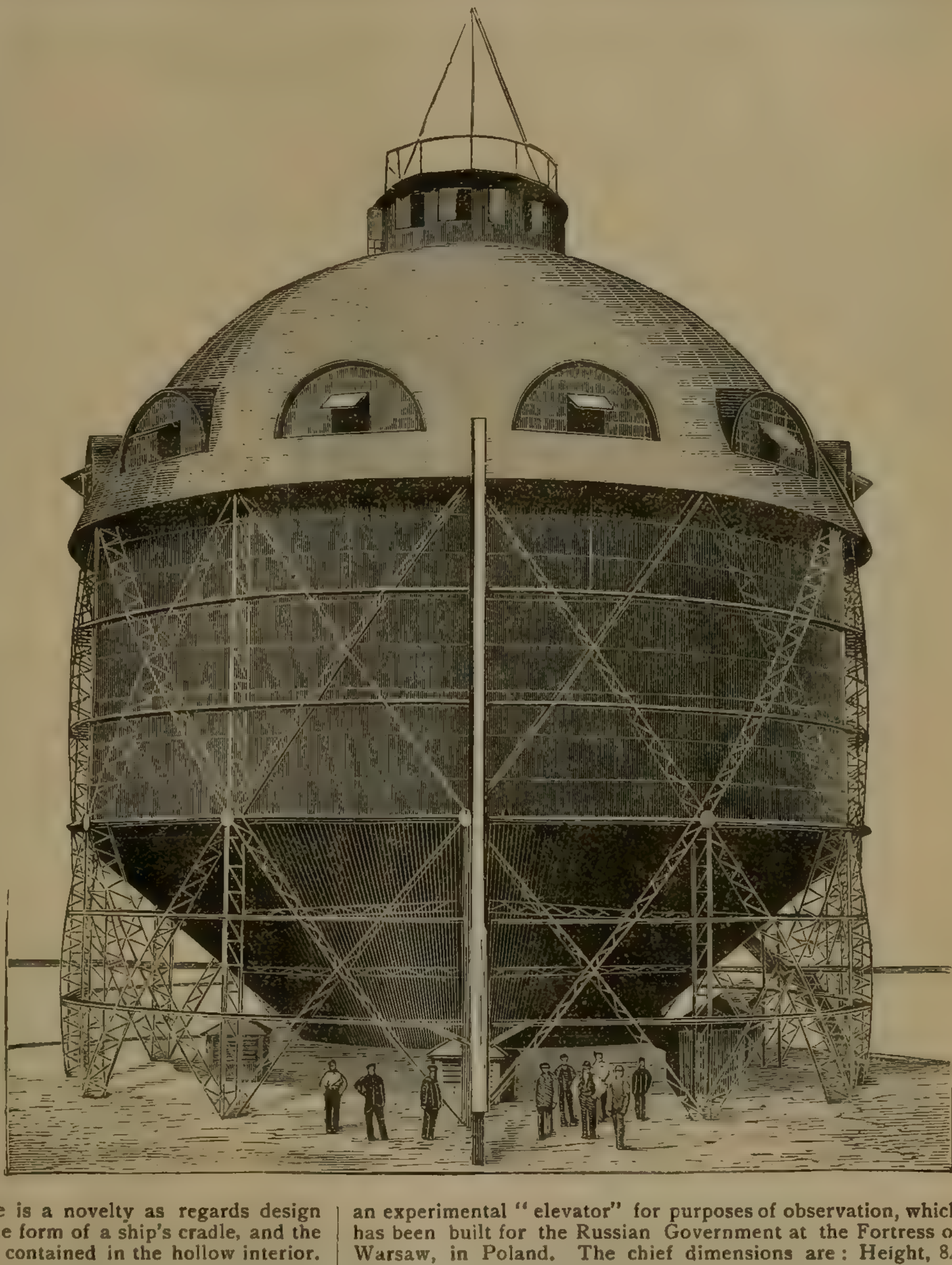
**Rare Metals.**—Some rare metals, possessing special qualities, are required for certain work. Thus palladium is used in making some parts of timepieces, and iridium for the points of gold pens, and the uninitiated have no idea of the value of such scarce products. Vanadium costs, for instance, 123 900 f. per kilogramme; zeconium, 79,295 f., and lithium, which is the lightest of metals, 77,090 f. per kilogramme. Rhodium, which is extremely hard and brittle, and is only fusible at a very high temperature, fetches 25,330 f.; and iridium, the heaviest substance hitherto discovered, costs 12,005 f. per kilogramme. It will therefore be seen that gold and silver are far from being the most precious metals as far as their market value is concerned. The cost of the most expensive metal, vanadium, is equal to $6,256 per pound; but the purchaser of a pound would probably "corner" the market.

**Panama Canal.** — It is stated in the *Engineer* that the latest scheme for the completion of the Panama Canal is the project of M. Amédée Sébillot, who proposes by means of a ship railroad to connect the two unfinished portions of the canal. The works would be completed in three years, and would cost $50,000,000. The locomotive is a novelty as regards design and construction. It is in the form of a ship's cradle, and the mechanism for propulsion is contained in the hollow interior. The cradle sinks under the vessel, draws it out of the water, makes the journey overland in two hours, and floats the ship in the other section of the canal without any further manœuvering. It is stated that the possibility of the scheme has been reported on by the Cail Company, who, in the event of the project being financed, would naturally have the contract for the iron and engineering work.

**Fifty-three Hours for a Week's Work.**—The Amalgamated Society of Engineers and other allied organizations have petitioned for a reduction of the hours of labor from 54 to 53 per week. They also ask for a uniform system of commencing and closing the week's work, namely, to start at 9 o'clock on Monday morning, work until 5.30 in the evening, and from 6 o'clock in the morning to 5.30 in the evening on Tuesday, Wednesday, Thursday, and Friday, and on Saturday from 6 o'clock in the morning until 12 o'clock at noon, thus completing the 53 hours.

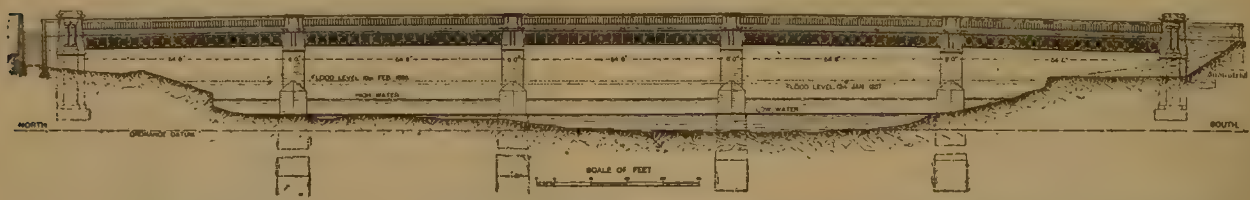
[If these hours are compared with those which mechanics are commonly required to work in this country, it will be seen that they are not very much better off than the down-trodden workman of Great Britain, the McKinley Bill to the contrary notwithstanding.—EDITOR.]

**A Russian Captive Balloon.**—The accompanying illustration, which has been sent us by a Russian correspondent, shows an experimental "elevator" for purposes of observation, which has been built for the Russian Government at the Fortress of Warsaw, in Poland. The chief dimensions are: Height, 84 ft.; diameter of cylindrical portion, 70 ft.; diameter of lower tapering portion varying from 70 to 31½ ft. The capacity is 24,000 *chetwert*, and to fill it with gas requires 100 hours. The cost of the machine was 80,000 roubles or about $36,000. The iron work was made in St. Petersburg, and put together upon the ground. The machinery in the upper portion is driven by a gas-engine of 12 H.P., which also runs the dynamo for the electric lighting. This engine was built at Warsaw. The arrrangement is not very clearly explained, but apparently the intention is that the upper part should rise, being retained or held down to the earth by the framework surrounding the gas-holder.



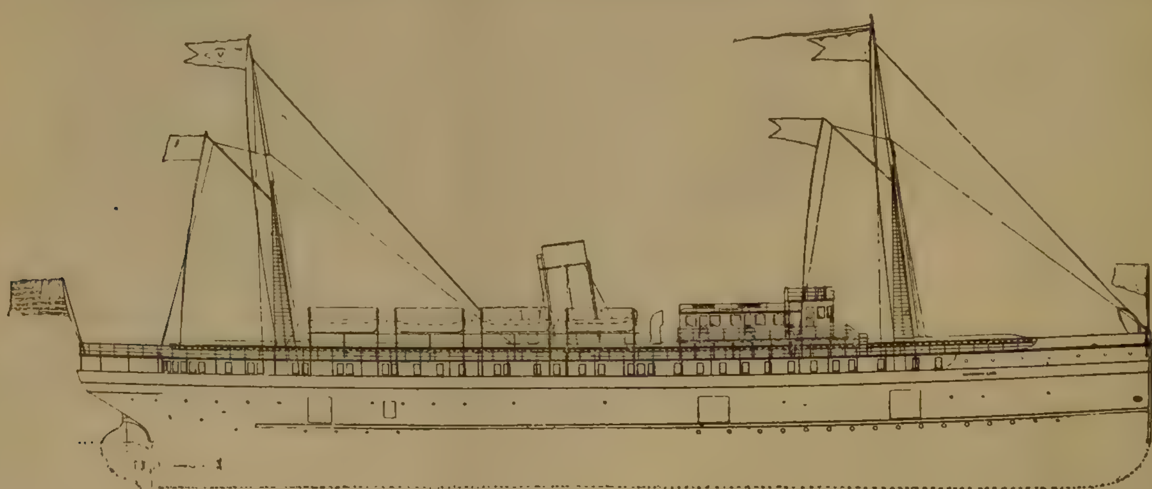
**The Dalmarnock Bridge.**—The accompanying illustration, from *Industries*, shows the new Dalmarnock Bridge over the Clyde near Glasgow, recently completed. It consists of five spans, each 54 ft. 8 in. in length; the roadway is 32 ft. wide, and there are two sidewalks, each 9 ft. wide. The superstructure consists of five parallel web-girders, 3 ft. 6 in. deep, carrying a floor of steel buckle-plates, which are covered with concrete, on top of which are the pavement for the roadway and sidewalks. The parapet is of cast iron.

The substructure consists of two abutments and four piers. The bed of the Clyde at this point is composed of muddy clay




and fine running sand overlying sandstone rock. In each case the foundation is formed on the rock, duly leveled and benched, the greatest depth attained being 56 ft. below river-bed. The piers were founded by means of caissons and compressed air. The caissons are rectangular in plan, with rounded ends, being 63 ft. over all by 9 ft. at the bottom, and 62 ft. 3 in. by 8 ft. 3 in. at the top. The piers, which are 62 ft. 3 in. over all, by 7 ft. 6 in. at cut-water level, and 53 ft. by 6 ft. above, are solid ashlar, and terminate in handsome moulded caps with fine red granite columns. The abutments call for no special remark, nor has their construction entailed any work of exceptional difficulty. The wing walls are curved, and handsome granite columns and moulded capping stones are in keeping with the rest of the structure.

**Sand-Moulding Machine.**—*Engineering*, in a recent issue, describes as follows Leeder's machine, which is now manufactured by the Patent Sand-Moulding Machine Company near Glasgow: "These moulding machines were first used in the Singer Manufacturing Company's Works, Kilbirnie, of which Mr. Leeder is manager, and proved a great success. The machine dispenses entirely with skilled labor, while the output is at the same time increased five or six times. The pattern is formed on the top and bottom sides of a parting plate, which is placed in position between the top and bottom moulding-boxes, which are then pressed together by hydraulic rams. These



rams are fitted in a cylinder constructed in the baseplate of the machine, one ram fitting inside the other, and they can be worked either together or separately. The lower box is carried by the outer of these rams, while a plate fastened to the inner ram serves as a support for the sand with which it is filled, and this sand can be ejected as one mass from the box by admitting water to the ram. Both the upper and lower boxes are guided by two cylindrical rods connecting the baseplate of the machine with a top plate or entablature above, which serves as a support for the upper core box when the pressure is turned on below the rams. A second rod between the baseplate to the entablature carries the parting pattern plate, and allows it to be swung clear of the machine, when the moulds are to be removed. In working the machine the bottom mould is first filled with sand; the pattern plate is then swung into position, and the upper box lowered on it and filled. The pressure is then turned on beneath the rams, and the boxes are pressed up against the entablature, which thoroughly rams the sand. On removing the pressure the bottom box and pattern plate descend with the rams, the former to the bottom of the machine, but the pattern plate is arrested by a stop midway between the boxes, and can then be swung out of position. The upper box is then lowered down to the bottom one again, and the sand forced out of the boxes as one mass by the inner hydraulic ram. The system is specially valuable for repetition work, as one man and a boy can, it is said, turn out 1,000 boxes per day."

**The Suez Canal.**—Suez Canal statistics are always interesting reading, and the report for 1890 affords proof of the steady progress of the world's commerce. Last year 3,389 vessels passed through the Suez Canal; this is 36 fewer than in 1889, but the total tonnage for 1890 was 6,890,014, or 106,676 tons in excess of 1889. The number of British vessels using the Canal last year was 2,522, or nearly 75 per cent. of the whole number. Next to Great Britain comes Germany with 275 vessels; France had 171, and Holland 144. Progress has been made in the time of transit through the Canal, the average time being 24 hours 6 minutes, or 1 hour 44 minutes less than in 1889. The use of the electric light has increased the facilities for vessels passing through the Canal, the journey by night being accomplished on the average in 22 hours 9 minutes, which is 21 minutes less than the average for 1889. It is now four years since the electric light was used, and the progress has been very great. In 1887 only 395 vessels employed the light, while last year 2,836 vessels used it. Most of the vessels obtain the apparatus from agents at Suez or Port Said, the light being supplied at a uniform rate of £10 for the transit. It is also to be noted that very few casualties took place during the year, and none of any importance.—*Nautical Magazine.*

**A Lake Passenger Steamer.**—The accompanying illustration, from the Cleveland *Marine Review*, shows the steamer *Virginia*, recently built by the Globe Iron Works at Cleveland for the Goodrich Transportation Company, to be used as a passenger boat on the line between Chicago, Racine and Milwaukee. The boat is fitted up in very handsome style, has accommodations for a large number of passengers, and is lighted throughout with electric lights.

The *Virginia* is 278 ft. long over all, 260 ft. keel, 38 ft. beam, and 25 ft. deep. She is propelled by twin-screws; each screw is driven by an inverted, direct-acting triple-expansion engine, with cylinders 20 in., 32 in., and 52 in. in diameter and 36 in. stroke. Steam is furnished by two double-ended boilers 13 ft. in diameter and 21 ft. 2 in. long, having 12 furnaces. The working pressure will be 160 lbs., and at 130 revolutions per minute the engines are expected to give the boat a speed of 18 miles an hour. There are eight auxiliary engines for the pumps, dynamos and steering gear.

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NEW YORK, JULY, 1891.

ON the recommendation of the New York Railroad Commissioners a new system of ventilation is to be tried in a section of the Fourth Avenue Railroad tunnel, about half a mile in length. Briefly described, this system consists in the construction of a false roof with a longitudinal slot or opening to admit the top of the locomotive stacks. The smoke and cinders will thus be thrown into the upper part of the tunnel, above the false roof, and will be drawn out by forced draft.

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THE Cape Cod Ship Canal, one of the largest projects of the kind in this country, has met with very varying fortunes. Several companies have been formed, and work has been actually begun upon the canal at several different times, but each time only to be stopped before any considerable amount had been done. The last company came to the end of its resources some time ago, and the Massachusetts Legislature has now given permission to a new company to undertake the work of constructing the canal. The Boston, Cape Cod & New York Canal Company, the new organization, has made very fair promises, and under the terms of the act is required to make a large deposit of money before obtaining its charter, a large part of this deposit to be forfeited in case the canal is not completed. The delay in the construction of this work is not altogether easy to understand, as its benefit to commerce would be undoubted, and there do not seem any serious difficulties to be overcome.

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IRON production for June, as given in the monthly statement of the *American Manufacturer*, shows a considerable increase, the number of furnaces in blast June 1 being greater by 16 than on May 1, while the weekly capacity has increased by 31,213 tons. The principal increase is in the bituminous and coke furnaces, but there are also nine more charcoal furnaces than on May 1. The anthracite production shows practically no change. The greatest increase in production has been in the Pittsburgh District, but there has also been a considerable change in Alabama, in Virginia, and in the Shenango Valley.

As compared with June 1, 1890, the production of charcoal iron, estimated by the weekly capacity of the furnaces, shows substantially no change. The anthracite furnaces show a decrease of 18 per cent. in the capacity of those in blast, and the bituminous and coke furnaces a decrease of about 17 per cent. It may be said, however, that the furnaces are recovering from the depression which marked the early part of the year, and the prospects are for a steady if not very large increase during the last half of 1891.

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WORK is now going on upon a line from Asheville to Rutherfordton, N. C., which is to be operated by electric motors. The dynamos furnishing the power will be run by water-power, the stations being located at convenient points. The distance between the two places is about 40 miles, and this is the longest electric railroad yet undertaken.

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THE Navy Department has decided to call for new bids for Torpedo Boat No. 2, and they will be received until August 18 next. The boat will be of not over 120 tons displacement, and must be built in one year. The minimum speed is to be 24 knots an hour, although the boat may be accepted on 22 knots, and a bonus will be paid for every quarter knot attained over 24. Bids may be made either on the Department plans or on builders' own design.

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IT is stated that the Navy Department is preparing to enter into an extensive course of experiments with torpedoes. A permanent Torpedo Board will be established, which will report directly to the Secretary, and under its charge tests will be made with the Whitehead, the Howell, the Hall and other auto-mobile torpedoes. The *Cushing* will also be thoroughly tested, with a view to possible improvements in the design of later torpedo-boats, and the Ericsson submarine boat *Destroyer* will be tried. The work of the Board will include means of defense as well as of attack, and devices for that purpose will be given a trial.

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THE later reports received concerning the sinking of the Chilian iron-clad *Blanco-Encalada* by torpedoes do not give the advocates of those weapons of attack very much comfort. It appears that the ship was anchored, no torpedo nets were in place, no guns in readiness for use, and no guard boats stationed. The torpedo-boats were enabled to approach her so closely that voices upon the deck could be heard. It was entirely a surprise, and no time or opportunity was given to use any of the means of defense against torpedo attack, which are provided on all modern cruisers. Four torpedoes were launched by the attacking boats—instead of seven, as reported in first accounts—and as nearly as can be determined, two of them took effect, one of the others being lost altogether, and one striking a dock in the harbor. It is believed by a number of those concerned that, had even an ordinary lookout been kept upon the *Blanco-Encalada*, she would have escaped destruction.

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THE opportunity for testing one of our new cruisers in actual war has passed by, the Chilian insurgents having surrendered the runaway steamer *Itata* without a contest. Of course war is to be deprecated, and it is well that a fight was avoided, but while the public generally

acknowledges that fact, it is somewhat in the position of a boy with a new knife, and would not have been sorry for a chance to see one of its new ships put to the test, a feeling not unnatural, though somewhat illogical.

In the chase the *Charleston* proved herself a good sea boat and a fast steamer. The criticisms made on her in some quarters for not catching the *Itata* are hardly well founded, and indeed are made chiefly by persons who do not realize the difficulty of finding a ship which has the start to begin with, and the whole Pacific Ocean on which to select her course. The chase must be wholly by guess-work, and the chances are tremendously against the pursuing ship, no matter how great an advantage she may have in speed.

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THE most important naval event of the past month was the letting of the contract for Cruiser No. 13, which is substantially a sister ship to Cruiser No. 12, or the "Pirate," as she is popularly called. Contrary to general expectation, the bid of the Cramp Company, which is building No. 12, was not the lowest, and the contract goes to the Bath Iron Works. That concern is comparatively new, as far as the building of large steel ships is concerned, but has already three naval contracts in hand, two of the smaller cruisers and the Ammen ram. The Bath Works have an excellent plant, and are said to be doing very good work. The engines of the new ship will be built at the Morgan Works in New York.

Cruiser No. 13 was the only large ship authorized this year. The only ships authorized which are not now under contract are Torpedo-boat No. 2; the torpedo cruiser, for which no bids were received; Dynamite Cruiser No. 2, which will not be begun until some decision is reached as to the success of the *Vesuvius*; and the so-called "Thomas Monitor," which has been practically dropped and will not be built.

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THE first of the 12-in. steel rifled guns built for the Army has been delivered at the proving ground at Sandy Hook, and the trials will begin as soon as it can be mounted. The gun has been built at the Watervliet Arsenal, where several others of the same caliber are now under construction to be used in the coast defense works, which will be built at Boston and New York.

This gun is a somewhat heavier piece than the Navy 12 in., being a little longer. It will carry a projectile weighing about 1,000 lbs., and the full service charge will be 440 lbs. of powder. The initial velocity of the shot is expected to be 1,940 ft. per second. It will be exceeded in weight and in initial velocity by the new Navy 13-in. gun, but is the heaviest piece yet completed for the Army, although the construction of several 16-in. guns will be begun as soon as the forgings are ready.

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## RAPID TRANSIT IN NEW YORK.

THE Rapid Transit Commission which has been considering the question of additional facilities for passenger transit in New York has made a preliminary report, giving its conclusions so far as the west side of the city is concerned. Briefly stated, they are that there is need of a line which will in part parallel the existing Elevated road, but will also extend beyond that line to the northern limit of the city, and will serve a district which is now delayed in its development by the lack of proper facilities for reaching it. So far the Commission holds only what almost every one in the city believes; but it has not gone as far as many citizens wish, and has approved only a single line, where most people who have thought over the matter carefully believe that two are needed. That the Commission's line is a good one few will be inclined to dispute, almost the only question being whether the single route approved is sufficient.

As to the kind of road to be built, the report makes two radical departures: the first in recommending a deep tunnel or underground line, and the second in approving of electricity as the motive power. In both of these the members were doubtless influenced by the reports of the successful working of the new City & South London line in London, an electrical line wholly underground and for most of its length from 50 to 60 ft. below the surface.

That a deep tunnel is practicable in New York, and at a cost upon which the traffic will pay interest, may be admitted without much dispute. There may be some objection to traveling underground at first, but this will soon disappear if there is a substantial gain in time. As to electricity as a motive power there will be more difference of opinion, especially when the particular system to be adopted comes to be considered.

Meantime the Commission's engineers are making surveys for its line. When the matter takes final shape, however, legal obstacles are much more likely to delay the work than engineering difficulties.

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## THE MASTER MECHANICS' CONVENTION.

IT is said that in some countries, where the inhabitants make much pretense of religion, their prayers are written on revolving sign-boards which are placed by the roadside, and that in order to save time in saying them, the devotees give the board a twirl with the ejaculation of Sam Weller, that "them's my sentiments." The late meeting of the Master Mechanics was so much like many which have preceded it, that in commenting on it we are tempted to refer our readers back to what has been written in previous years, and add the remark that what was written then will apply to the meeting which has just been held.

There were this year perhaps a few more of the same kinds of people present that usually attend the meetings. The master mechanic was there in force. The superintendent of machinery was in a minority, apparently doubtful whether it was not beneath his dignity to be present and take part in the proceedings. The "representative" of various manufacturing interests was there in a large majority; the wives, the sisters, the cousins, and the aunts of the masculines in attendance decorated the borders of the assemblage as plots of flowers ornament a vegetable garden. There was an exhibition of a great variety of appliances, with attendants who could talk like water-wheels. The inventor was there, as solicitous of his creation as a cow is of its calf. The "crank" lingered on the outskirts, hollow-eyed and anxious. There was an entertainment committee with extended hands for "assessments." There were carriages and flowers for the ladies, dancing by night and music by day—young ladies and old, flirtatious girls and coy maidens, dudes and hard-handed sons of toil. The ocean was there, and the people bathed and fished in it, and told fish stories afterward. There was a laboratory in a back room, where the laws of chemical

affinity were illustrated by inverting a metal frustrum of a cone over a glass vessel of similar form, and then agitating the contents. When the reaction was complete the experiment was continued by the audience, who put themselves outside of the chemical combination. In some cases another reaction occurred about a half hour afterward, attended with more or less ebullition of jollity.

The following is a list of the reports which formed the programme of the meetings, with the committees thereon :

1. Exhaust Pipes, Nozzles and Steam Passages. *Committee :* C. F. Thomas, A. W. Gibbs, L. C. Noble, F. C. Smith, John Y. Smith.

2. Testing Laboratories, Chemical and Mechanical. *Committee :* George Gibbs, G. W. West, L. S. Randolph, D. L. Barnes.

3. Advantages and Disadvantages of Placing the Fire-box above the Frames. *Committee :* F. B. Griffiths, James Macbeth, W. A. Foster, A. G. Leonard, L. F. Lyne.

4. Relative Value of Steel and Iron Axles. *Committee* : John Mackenzie, J. S. Graham, John S. Cook, E. B. Wall, Thomas Shaw.

5. Purification or Softening of Feed-Water. *Committee :* W. T. Small, H. Middleton, A. W. Quackenbush, J. B. Barnes, John W. Hill.

6. The Present Status of the Car-Coupler Question. *Committee :* John Hickey, G. W. Rhodes, Sanford Keeler, R. H. Blackall, M. N. Forney.

7. Examination of Locomotive Engineers and Firemen. *Committee :* W. H. Thomas, John Player, F. D. Casanave, J. W. Luttrell, L. R. Pomeroy.

8. Operating Locomotives with Different Crews. *Committee :* Ross Kells, W. W. Reynolds, W. F. Turreff, C. G. Turner, John A. Hill.

9. Locomotives for Heavy Passenger and Fast Freight Train Service. *Committee :* P. Leeds, James Meehan, E. M. Roberts, C. E. Smart, W. A. Smith.

10. Electrical Appliances for Railroad Use. *Committee :* T. W. Gentry, G. B. Hazlehurst, Albert Griggs, John Ortton.

11. Standards of the Association. *Committee :* William Swanston, William Garstang, C. H. Cory, J. S. McCrum, Thomas Shaw.

13. Air-Brake Standards and Inspection and Care of Air Brakes. *Committee :* R. C. Blackall, G. W. Stevens, D. Clark.

14. On Bringing Conventions Closer Together. *Committee :* O. Stewart, Charles Graham, D. Clark, G. W. Stevens, John Mackenzie.

15. Subjects for Investigation and Discussion. *Committee :* William H. Lewis, John Wilson, P. H. Peck.

16. Disposal of Boston Fund. *Committee :* J. N. Lauder, J. N. Barr, Angus Sinclair.

On another page we give a brief report of the proceedings. There was nothing very remarkable about them. The discussions were generally rather tame, excepting on the subject of compound locomotives. Representatives of the Baldwin and Schnectady locomotive works presented the claims of two and four-cylinder locomotives, but the members generally were rather chary of expressing opinions. Altogether, there is not much to say of the meeting, excepting that it was held—in the usual way. The attendance was a little larger than heretofore, showing a steady growth in that respect. The reports were neither better nor worse than usual—none of them were remarkably good, although some were uninteresting.

One member was sat upon by the graduates of technical schools for saying that he could not, in his experience, recall an instance in which any one by the use of an indicator had found out anything about a locomotive which was worth knowing. In the discussion which followed some of those who took part in it attempted to crush this member, as a housewife rolls out incipient pie crust. He still lives, however.

The disposition of the Boston fund was, it will be seen, the subject of a special report by a committee. As probably only the older members of the Association know how this fund originated, it may be well to say that when one of the conventions was held in Boston quite a number of years ago a local entertainment committee organized there had a surplus left after all expenses were paid. This was donated to the Association, and has been drawing interest ever since. The money promised to be a source of trouble to the Association, and for that and other reasons it was desirable to make some disposition of it. This has been done by creating a scholarship in the Stevens Institute of Technology, which is open to the son of a master mechanic who passes the best examination. The fund thus becomes the source of perpetual benefaction to descendants of the present members. It is to be regretted that a part, at least, of the large sums of money which are expended each year for the entertainment of members cannot be diverted into a like channel.

The place of meeting for next year has wisely been referred to a joint committee of the Master Mechanics' and the Master Car Builders' associations, and it is proposed to begin the convention of the latter body on Wednesday, and of the former on Monday, so that from the beginning of the session of the one association to the end of that of the other will occupy only eight days. A good deal of complaint is now made of the time consumed by the two meetings. A better plan than that proposed would seem to be to hold the first session of the Car Builders' meeting on Monday evening, and thus dispose of the routine work of the first session. Then devote Tuesday and Wednesday to this Association. On Wednesday evening the first session of the Master Mechanics could be held, and Thursday and Friday devoted to its meetings. In this way the meetings of the two associations could be held in four days, which would save much time and money.

## ENGINEERING AT THE EXHIBITION OF 1893.

THE movement for the establishment of special headquarters for Engineers and of a special department of Engineering at the great Exhibition of 1893 assumed form at a meeting held in Chicago in May, at which there were represented the American Society of Civil Engineers ; the American Society of Mechanical Engineers ; the American Institute of Mining Engineers ; the American Institute of Electrical Engineers ; the Canadian Society of Civil Engineers ; the local Engineers' societies of Boston, Philadelphia, Pittsburgh, Cleveland, Chicago, St. Louis, St. Paul, Minneapolis, the South, Kansas City and Montana. All of these had appointed delegates, and a large proportion were present.

After due consultation the movement was given an organization by the choice of a President and Executive Committee, and the delegates from the various societies resolved to assume the name of the "General Committee of Engineering Societies, Columbian Exposition." The objects of this Committee were defined as follows :

1. To provide on behalf of the Engineering Societies represented on this Committee Engineering Headquarters for members of all Engineering Societies of the world, who may visit Chicago during the World's Columbian Exposition in 1893.

2. To promote an International Engineering Congress to be held in Chicago in 1893 under the auspices of the World's Congress Auxiliary of the World's Columbian Exposition.

The management was placed in capable hands, Mr. Octave Chanute being chosen President, with the following members of the Executive Committee : E. L. Corthell, E. M. Izard, William Forsyth, C. L. Strobel, Robert W.

Hunt, John W. Cloud and D. J. Whittemore. A Secretary and Treasurer are to be chosen.

The Committee also passed a resolution to the effect that "the importance of Engineering entitles it to the place of an independent department in the World's Congresses, to be held in 1893, under the auspices of the World's Columbian Exposition." This seems to be so plain as hardly to admit of discussion.

It may be noted also that the Master Car-Builders' and the Master Mechanics' Associations have both passed resolutions in favor of co-operation in the Exhibition, and have appointed committees to outline the form which their assistance should take.

It is to be hoped that all classes of engineers will assist, and that they will work together in securing a proper representation at the Exhibition, which will, indeed, be largely a showing of the result of their labors.

## ENGLISH AND AMERICAN LOCOMOTIVES.

THE *Engineer* of May 22 contains another article on the above subject, in reply to one which appeared in the May number of this JOURNAL. The answer will be deferred for another month, when we expect to give some data bearing upon the subject.

At the conclusion of his article the editor of *The Engineer* says:

> Our contemporary reverts to a proposition he made long since, which strikes us as being a very curious proposition. It is that we should publish drawings of a large English express passenger locomotive, and the same of a goods engine. . . . It would appear that the RAILROAD AND ENGINEERING JOURNAL is in ignorance of the fact that we have published drawings and particulars of all the best English locomotives, and that we continue to publish such drawings, representing every change in practice, from time to time, as occasion arises. Precisely what more our contemporary needs for the purposes of comparison we are at a loss to understand.

We are not in ignorance of the fact that *The Engineer* from time to time has published admirable engravings of English locomotives. What we do not know is, which of them, in the judgment of our contemporary, fairly represents British practice of the present day. If the editor of *The Engineer* will point out which of the heavy passenger engines that have been illustrated in its pages represents that practice, it will be possible then to compare its design and construction with that of an American engine of like weight and capacity. It should be added that, as compound locomotives are not very extensively used in England, and are hardly out of the experimental stage here, they should be excluded in making such a comparison.

## THE VAUCLAIN COMPOUND LOCOMOTIVE.

WE have received from the inventor of this locomotive a communication in which he disputes the statements made by M. Mallet in the article which was published in our April number. In this article M. Mallet, in speaking of Mr. Vauclain's design, said that:

> The lowest point of the large cylinder is 22 in. below the common axis, and unless the cylinders are inclined, which is contrary to American custom, the wheels could hardly have a diameter less than 56 in., which is greater than is generally used for a consolidation engine, where the wheels are usually 48 or 50 in. in diameter.

Mr. Vauclain has written that:

> We (that is, the Baldwin Locomotive Works) are making compound locomotives of the four-cylinder type with driving-wheels 24 in. diameter and upward, and also for all gauges of track from 20 in. up to 5 ft. 6 in., the widest now in use in South America.

He has sent us some photographs from which the engravings herewith have been made, and which illustrate some features in the construction of this class of locomotives.

COMPOUND CONSOLIDATION LOCOMOTIVE, VAUCLAIN SYSTEM.

Fig. 1 represents a compound consolidation locomotive of the Vauclain type. In this it will be seen that the small, or high-pressure cylinder is below, and the large, or low-pressure cylinder is above. Fig. 2 shows the front end of an engine with the same arrangement of cylinders, but with frames outside of the wheels. Fig. 3 represents an engine with the same kind of frames, but with the cylinders reversed in their relative positions. Fig. 4 shows a similar view of an engine of the American type, but with the high-pressure cylinder above and the low-pressure cylinder below. All these engines, excepting the last one, have wheels smaller than 56 in. diameter, showing that the plan is adapted to be used with small wheels and horizontal cylinders.

At the Master Mechanics' Convention, held in June, Mr. Vauclain stated that the firm he is connected with has orders for over 40 compound locomotives of his four-cylinder type. During a recent visit to the Baldwin Locomotive Works we found a large number of these engines in progress, and apparently their manufacture is an established branch of the business of the firm.

In some recent trials Mr. Vauclain reports an economy of from 35 to 40 per cent. of his type of engine over some non-compound engines. This, if confirmed by regular

practice, will be an extraordinary result, and will place the economy of the compound locomotive beyond further dispute. He also says :

Another item of interest to you will be the reliable data I have gathered in relation to piston rods. We have never had any complaint from this source, and M. Mallet can rest secure so far as that is concerned. When out with the last large consolidation, I ran the engine 10 miles, using high-pressure steam in the low-pressure cylinders, and had to keep sanding the rail all the time in order to keep to the rail—with no kinking of the piston-rods at all.

These statements, and the engravings, will be sufficient to show that M. Mallet's criticism was based on a misunderstanding.

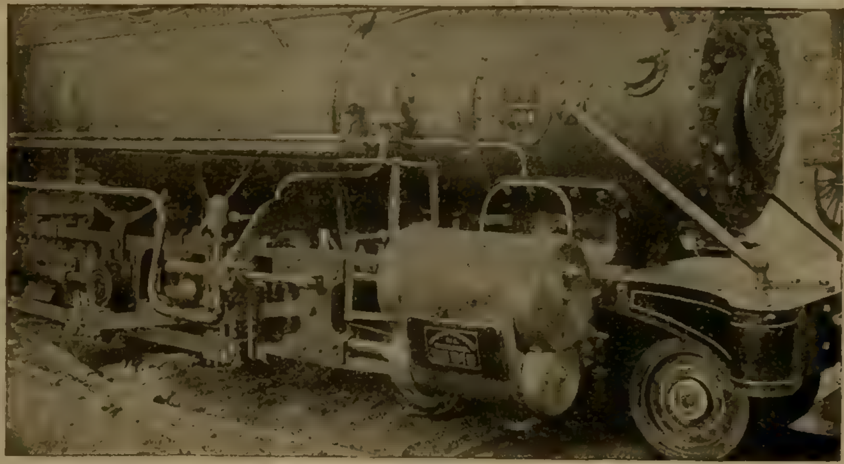


Fig. 2.

## THE TRIAL OF THE VESUVIUS.

THE recent trial, in Chesapeake Bay, of the dynamite cruiser *Vesuvius*, although not successful in determining the actual value of that vessel, has yet clearly demonstrated to those who have studied the experiments, the tremendous force of this arm of warfare.

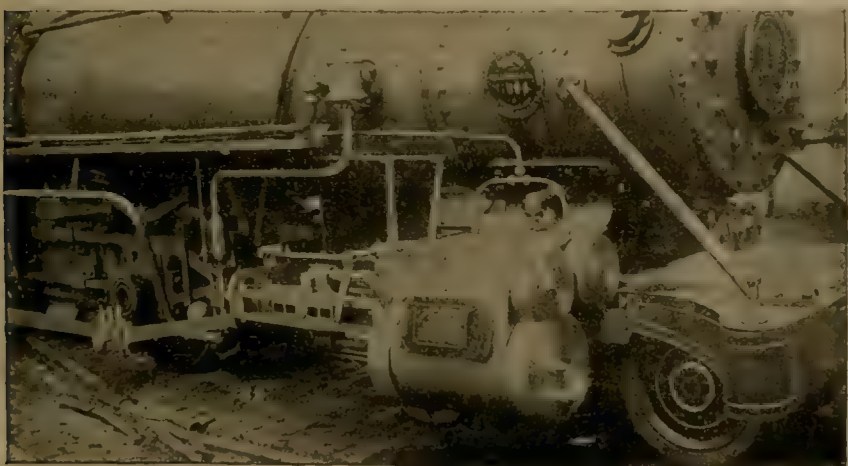


Fig. 3.

Since the trial the verdict among naval and military officers has been practically unanimous that there is more accuracy in this high angle of fire than had been first supposed ; and if the experiments have had no other success, they have at least succeeded in creating among army and navy men ten times as many advocates for the dynamite cruiser as formerly existed.

It is unfortunate that the trial was conducted under circumstances tending to make apparently a target-practice out of what was in reality an operation for determining the ranges of the pneumatic guns.

It was well known beforehand that the tubes would carry the projectiles to a distance much further than that reached by any of those fired in Chesapeake Bay. It was also well known beforehand that the principle upon which the pneumatic gun is constructed requires and presupposes a table of ranges, determined by experiment—an operation that had not been performed for the three pneumatic tubes prior to the visit of the Board.

The compressed air, which is the expelling power, and which is always under constant pressure, is admitted to the base of the projectile by the opening of a valve ; and therefore it necessarily follows that the period of time during which the valve remains open, or even the amount of its aperture that is opened, directly influences the range of the projectile. Indeed, so minutely does the amount of time occupied in opening and closing the valves affect the range, that in the late trial it was noticed that the slight loss of motion due to the change in turning the valve from one direction back to the other direction became apparent in the distance to which the projectile was carried.

The Board of Officers who conducted the first trial con-

Fig. 4.

sidered that the tests were not exhaustive enough to warrant them in reporting upon the actual efficiency of the vessel; and the same Board are to conduct a second series of experiments. This is particularly fortunate, since these gentlemen will have profited by their observations made during the trial in Lynnhaven Roads.

Two essential points have been clearly demonstrated—first, that it is absolutely necessary to know approximately the distance of the object to be struck; and, second, the valve-system must be absolutely arranged to admit at all times the required amount of compressed air, and no more.

As a favorable offset to the fact that these two necessities exist, it has been distinctly shown that the line of fire from the pneumatic guns is excellent, and that the pitching of the vessel, even in a comparatively rough sea-way, but little affected the range of the projectile. These two points were the ones upon which the greatest doubt had existed in the minds of naval men, and the trial, no matter how unsatisfactory in other respects, has entirely dissipated these doubts.

In all but 26 projectiles were provided for the ranging and subsequent testing of the three tubes. On May 18, the first day, 11 of these were fired to find the range of the guns, six being fired from the starboard gun and five from the middle gun. The port gun was not tested. This number of shots was, as a matter of course, inadequate to determine an accurate table of ranges, and therefore attention was confined to only these two guns.

On May 19 an informal target-practice was made by firing nine of the remaining shots at known distances from the target. Six of these were fired with the Vesuvius stationary, and three of them with the Vesuvius steaming toward the target at the rate of 12½ knots. Of these shots, a table of which is given below, three were in exact line, one being a bull's-eye. The greatest deviation to the right or left of the line of fire was 52 yards at a distance of a mile, and the greatest amount short of the target was 28 yards, at a distance of half a mile. Six of the nine shots would have destroyed a vessel the size of the *Dolphin.* The modern battleship would present a rectangle of about 150 yards by 40 yards. If a shell loaded with dynamite can be dropped on any part of this rectangle the shot should be considered a success, for 500 lbs. of dynamite falling that close to any part of a vessel and exploding is bound to create havoc.

Inasmuch as this informal trial had been so satisfactory, and in consideration of the fact that the remaining six projectiles were needed for the official trial, no further effort was made to accurately range the valves, and on May 20 the official trial was made, the results of which were not, unfortunately, in any degree as successful as those of the day before.

A table of the shots made on May 20 is also given herewith. Only two of the shots fired this day would, to a casual observer, or upon an ordinary inspection of the table, be considered good ones. One of them, the first shot fired, was thrown while the vessel was going at a speed of 12½ knots toward a stationary target, and the other, the fourth shot, while the vessel was going at a speed of 17½ knots, and at a target moving at a rate of 10 knots.

The other shots of this day's trial were, at first glance, apparently entirely unsuccessful, one going 250 yards short and one 300 yards beyond the target. Still when we consider that the "target" in question was an ordinary

Table of Shots, May 19, 1891, "Vesuvius."

| Number of Shot. | Dist. of Target. | Dev. from line, yds. over or under. | Range, yds. over or under. | Remarks. |
|---|---|---|---|---|
| 1. | 1 mile. | 0. | 52 over. | *Vesuvius* stationary and distance known. |
| 2. | ¾ " | 16 L. | 48 over. | |
| 3. | ½ " | 0. | Bull's-eye. | |
| 4. | 1 mile. | 52 L. | 32 over. | *Vesuvius* steaming toward target at rate of 12½ knots. |
| 5. | ¾ " | 0. | 24 over. | |
| 6. | ½ " | 16 L. | 28 short. | |
| 7. | 1 mile. | 24 L. | 4½ short. | *Vesuvius* stationary and distance known. |
| 8. | ¾ " | 15 L. | 35 short. | |
| 9. | ½ " | 10 L. | 28 short. | |

Table of Shots, May 20.

| | | | | |
|---|---|---|---|---|
| 1. | 1 mile. | 0. | 56 over. | *Vesuvius* steaming 12½ knots toward target. |
| 2. | ¾ " | 16 R. | 104 over. | |
| 3. | ½ " | 24 R. | 24 short. | |
| 4. | 1 mile. | 20 L. | 16 short. | *Vesuvius* steaming 17½ knots toward a cutter towed by the *Cushing* at 10 knots. |
| 5. | ¾ " | 0. | 300 over. | |
| 6. | ½ " | 8 L. | 275 short. | |

naval cutter, probably not over 2 ft. in height and 30 ft. in length, some of these shots appear to better advantage when analyzed according to the effect they would have produced had they been fired at a target the size of an ordinary man-of-war.

For example, the second shot, fired on the day of the official trial, with the target at a distance of 0¾ mile, went 16 yards to the right, and struck 104 yards beyond the target. The tubes are placed at an angle of 18° elevation, and with the above data it can be easily seen that this shot, that figures apparently as a poor one, would, if it had been aimed at the midship line, certainly have struck some part of a vessel the size of the *Newark.*

The dynamite gun is essentially an American invention, and the excellent results obtained with it at Shoeburyness, where it continually deposited its projectiles within a rectangle of about five by eight yards, have decided the European powers to avail themselves of this as a method of coast defense.

The placing of the gun on a floating platform is also an entirely American "notion," which our British cousins hastened to declare would be unsuccessful; but they will not be slow in borrowing from us this idea as well, after we have demonstrated that "the thing will work."

The Fiske range-finder, which was mainly invented on account of the trouble that that officer foresaw to obtain an exact distance of ranges aboard this vessel, will at all times give the distance of the target from the vessel. It is now reported that before the next and final trial of the little vessel, this range-finder is to be placed aboard of her; and if this be done, one of the disadvantages that before existed will have been overcome, as the distance of the target at any time will be approximately shown.

Many officers of the Navy, who before the time of this trial had little interest or belief in the efficiency of the vessel, have now become enthusiastic over her performance, and are confident that before the time of the next trial American invention will have devised a more perfect

system of discharging valves, and that her next experiments will be an entire success.

The vessel will receive a fair, patient and impartial trial from the Board appointed to inspect her, and criticism should be suspended or, at least, condemnation should be withheld until it has been decided that the supposed defects may not be necessary ones.

## NEW PUBLICATIONS.

FOURTH ANNUAL REPORT OF THE BOARD OF PUBLIC WORKS OF THE CITY OF DULUTH, MINN. *For the Year ending February 28, 1891.* Duluth, Minn.; issued by the City.

This report shows that a great variety of public work has been executed in Duluth during the past year, but its chief interest is in what is proposed for the future. The most important work is a tunnel under the ship canal on Minnesota Point—the main entrance to Duluth harbor—on which question a report by Mr. William Sooy Smith is given. After considering the requirements of the case, he recommends the building of a tunnel with three galleries, two to carry one railroad track each, the third a street railroad track and a footway for passengers. The tunnel is presented as the best plan for securing a crossing which is very much needed. For the approaches a 10 per cent. grade is recommended, the traffic to be worked by a rack-rail locomotive on the Abt system.

It is understood that these recommendations will probably be adopted and a tunnel built.

WHO OWNS THE LAKE BEDS? By F. Hodgman. Battle Creek, Mich.; published by the Author.

This is a reprint of a paper read before the Michigan Engineering Society at its last meeting on a subject which has caused much controversy in the Northwest and, in one case at least, has led to litigation of considerable importance. The question refers to the beds of the small lakes found on the public lands, or lands which have been public, within the regions subdivided by the United States Survey. After a careful examination of the authorities and of Government practice Mr. Hodgman concludes that the beds of non-meandered lakes belong to the owners of the adjoining land; that the beds of meandered non-navigable lakes belong to the General Government; that the beds of navigable lakes belong to the State. Where the waters of a lake recede permanently, the land so gained belongs to the owners of the adjoining land.

The subject is a somewhat curious one, and is of interest to land surveyors and land-owners in many places.

BRICK PAVEMENT. *The Inauguration and Execution of the Work; the Manufacture of Brick; with Tables of Experiments and Tests.* By C. P. Chase, City Engineer, Clinton, Ia. (Indianapolis; *Paving and Municipal Engineering*; price, $1).

The use of brick for street pavements is rapidly extending in the West, and especially in those sections where stone suitable for paving purposes is not easily obtainable. Doubtless its use would be still more extended were engineers better informed as to the qualities of the material, its capabilities and the reasons in favor of its employment. Wood pavements have not proved generally durable; asphalt is expensive in many sections of the country, and stone is also expensive when it has to be transported long distances overland. Engineers in many cities and towns are therefore interested in knowing what has been done with brick, how far it can be relied on under light and heavy traffic, what is the best quality for street use, and other points in relation to it.

This information Mr. Chase has sought to present in a concise form, his book being, as he says, not for those who have "been through the mill," but rather for those who are looking for knowledge and advice. The book contains first a preliminary section on the general question of paving, including preparation of the roadway and foundations, and then the more special part on paving brick and the best methods for using it. This includes a number of tests of brick and comparative tables showing the strength of bricks of different makes and their relative standing in other respects. There is also a description of various methods employed in laying pavements, with notes of experience with such methods. These are made clearer by illustrations.

As to the merits of brick pavements, Mr. Chase gives a table of comparative excellence of various paving materials based upon the latest experiments and facts taken from actual service, which is as follows:

| Qualities. | Relative Rank of Materials. 1. | 2. | 3. | 4. | 5. |
|---|---|---|---|---|---|
| Durability under traffic | Granite | Brick | Asphalt | Sandstone | Wood |
| Cost | Brick | Wood | Sandstone | Asphalt | Granite |
| Action of elements | Brick | Granite | Sandstone | Asphalt | Wood |
| Noise and dust | Asphalt | Brick | Wood | Granite | Sandstone |
| Repairs | Brick | Granite | Sandstone | Asphalt | Wood |
| Service on grades | Granite | Brick | Sandstone | Wood | Asphalt |
| Health | Asphalt | Granite | Brick | Sandstone | Wood |

The concluding—and not the least valuable—part of the book is a complete set of specifications for brick paving. These have been used in actual practice, have stood the test of experience, and seem to be very complete and satisfactory in form and details. They will undoubtedly be of much service to city engineers and others who have to prepare for using such pavements for the first time.

GEORGE P. ROWELL'S BOOK FOR ADVERTISERS. (New York; George P. Rowell & Company; price $1.)

This book contains a number of lists of papers and other information based upon the long experience of the publishers in the business. While there are some mistakes in it, it must be of great service to the general advertiser who has not the time or opportunity to make himself acquainted with the papers through which he wishes to address the public. The special advertiser, who uses class or trade papers, has a narrower field, and can more easily work on his own account, but he also may find good advice.

The total number of periodical publications in the United States and Canada is given in this book as 19,373. New York has over 10 per cent. of these, or 1,958, and the number gradually decreases until we come to Alaska, which supports 3. The labor of keeping up a current acquaintance with nearly 20,000 papers can hardly be estimated, and it can only be accomplished by a carefully arranged system.

## BOOKS RECEIVED.

*Occasional Papers of the Institution of Civil Engineers.* London, England; published by the Institution. The present issue includes papers on Authorities on the Steam Jacket, by Professor R. H. Thurston; Machine Stoking, by J. F. Spencer; Influence of Heat on the Strength of Iron, by Professor Martens; the Port of Swansea, by R. Capper; Auxiliary Engines, by W. H. Allen; Governors and Fly-Wheels, by Professor Dwelshauvers-Dery; the Von Schmidt Dredge, by George Higgins; Abstracts of Papers in Foreign Transactions and Periodicals.

*Boiler Tests: Embracing the Results of* 137 *Evaporative Tests, Made on* 71 *Boilers, conducted by the Author.* By George H. Barrus, S.B. Boston; published by the Author (price $5). This book is received too late to have the careful review which it requires given in the present number. It is a volume of 280 pages, with many illustrations.

*Transactions of the Denver Society of Civil Engineers: Volume II, July-December,* 1890. Denver, Col.; published for the Society.

*Proceedings of the Third Annual Convention of the Iowa Society of Civil Engineers and Surveyors, held at Des Moines, December* 30 *and* 31, 1890. Glenwood, Ia.; published by the Society; Seth Dean, Secretary (price, 35 cents).

*Cornell University, Agricultural Experiment Station: Bulletin* 27, *May,* 1891. Ithaca, N. Y.; published by the University.

*University of Illinois, Catalogue and Circular.* Champaign, Ill.; published by the University.

*Purdue University: Annual Register,* 1890–91, *with Scheme of Study for* 1891–92. Lafayette, Ind.; published by the University.

*A Treatise on the Calkins Steam Indicator, with Descriptions of Calkins' Graduated Pantograph, Polar Planimeter, etc., etc.* New York; the Engineers' Instrument Company (price, $1.50). This book is reserved for more careful review than time will permit in the present number.

## TRADE CATALOGUES.

*Catalogues and Price Lists of the Brown & Sharpe Manufacturing Company, and of Darling, Brown & Sharpe.* Providence, R. I. This is a new edition of the catalogue of these well-known firms, containing several additions in the way of new machines, etc., not included in previous issues.

*The Swenson Patent System of Evaporation by Multiple Effects. The Fort Scott Foundry & Machine Works Company, Fort Scott, Kansas.*

*The Star Ventilator: Illustrated Catalogue. Merchant & Company, Philadelphia.*

## ABOUT BOOKS AND PERIODICALS.

AMONG the new books in preparation by John Wiley & Sons is STONES FOR BUILDING DECORATION, by George P. Merrill, of the National Museum at Washington.

A very neat pamphlet called OVER THE CINCINNATI SOUTHERN was issued by the Cincinnati, New Orleans & Texas Pacific Company on the occasion of the Civil Engineers' Convention in Chattanooga. It contained a brief account of the road, with view of the Kentucky River Bridge and of Lookout Mountain, and a map giving also a profile of the road and showing the geological formations of the country. It was an excellent traveling companion.

In HARPER'S WEEKLY for June 10 there is a fine double-page portrait of Thomas A. Edison in his laboratory. Other recent numbers have had illustrated articles on the Chicago Parks, on the Adirondack Forests, and on the new Boulevard Tunnel under the Chicago River.

The May number of the JOURNAL of the American Society of Naval Engineers has articles on Trial Trips, by Chief Engineer N. P. Towne; Preservation of Marine Boilers, by Assistant Engineer S. H. Leonard; Engine Room Signals, by Assistant Engineer H. P. Norton; Trial of the *Bennington*, by Assistant Engineer Albert Moritz; Economic Marine Propulsion, by Chief Engineer John Low; Development of Cylindrical Heads for Boilers, by Assistant Engineer H. G. Leopold.

Almost every healthy man takes an interest in some kind of outdoor amusement, and accordingly every one will find something to suit him in OUTING for June. There are also some entertaining notes of travel. The military article for the month is on the Massachusetts Volunteer Militia, beginning with the companies of nearly 200 years ago—for Massachusetts military history runs back almost to the first settlement of Plymouth and Boston.

The JOURNAL of the New England Water-Works Association for June has several interesting papers and discussions. The one which has the most general importance is on Typhoid Fever in its Relation to Water Supplies, by Mr. H. F. Mills, of the Massachusetts State Board of Health.

The article in Mr. Child's South American series in the July number of HARPER'S MAGAZINE is on Paraguay. Colonel Dodge writes of the Cowboy and the Mexican Vaquero in his series on American Riders. The illustrations and the miscellaneous articles make this a most excellent Summer number.

Probably the papers which will attract most attention in the June ARENA are Editor Flower's on Society Exiles and Camille Flammarion's on the Unknown. One of special value to engineers is on Irrigation in the Northwest, which is the result of careful study of the question.

The June number of the LEHIGH QUARTERLY will be an especially interesting one to graduates of the Lehigh University, containing several articles on the University itself and student history. Among the general articles are Reading and Indexing, by Professor Ira O. Baker; Nitro-Glycerine, by Albert Eavenson; Wrought iron Compression Members, by Henry S. Prichard; the Telephone, by J. Z. Miller.

The range of selection in the ECLECTIC MAGAZINE for June is shown by the fact that it contains articles from the *Gentleman's Magazine*, the *Contemporary Review*, the *Nineteenth Century*, the *Fortnightly Review*, the *National Review*, the *Saturday Review*, *Blackwood's Magazine*, the *Spectator*, the *Academy*, and the *New Review*—a list which pretty well covers the English magazines of standing.

Wool Spinning and Weaving; Sanitary Improvement in New York; Agricultural Experiment Stations, and Man and the Glacial Period are the leading articles in the POPULAR SCIENCE MONTHLY for July. The first one named is one of the series on American Industries, which has formed a feature of this magazine since the beginning of the year.

The more serious articles in BELFORD'S MAGAZINE for June are on the Wage System, by Eva McDonald; on Physical Culture, and on Foreign Trade and Reciprocity Abundance of reading is also provided for those who look for amusement rather than instruction in a magazine.

The April number of the SCHOOL OF MINES QUARTERLY is chiefly a mining number, and has several valuable articles on mining and metallurgy.

In the July number of SCRIBNER'S MAGAZINE Foster Crowell gives an Engineer's Glimpse of Hayti, including some interesting particulars concerning that fertile but very uneasy island. The steamship article is on Speed, and is by A. E. Seaton. Impressions of Japan, some stories of Mexican outlaws, and some very readable stories and other lighter matter complete the number.

A quarterly journal has been started in Chicago to advocate the use of brick for paving purposes. BRICK ROADWAYS is the appropriate name, and it is edited by Charles T. Davis.

## THE ARMSTRONG RAPID-FIRE GUN.

(From *Industries.*)

THE accompanying illustrations show one of the rapid-fire guns shown at the Naval Exhibition by the Elswick Works of Sir W. G. Armstrong, Mitchell & Company. The gun illustrated is of 4.7-in. (12 cm.) caliber. Fig. 1 is a general view of the gun as mounted; fig. 2 is an elevation; fig. 3 a section; fig. 4 an end-view, and fig. 5 a section on a larger scale, showing the breech mechanism.

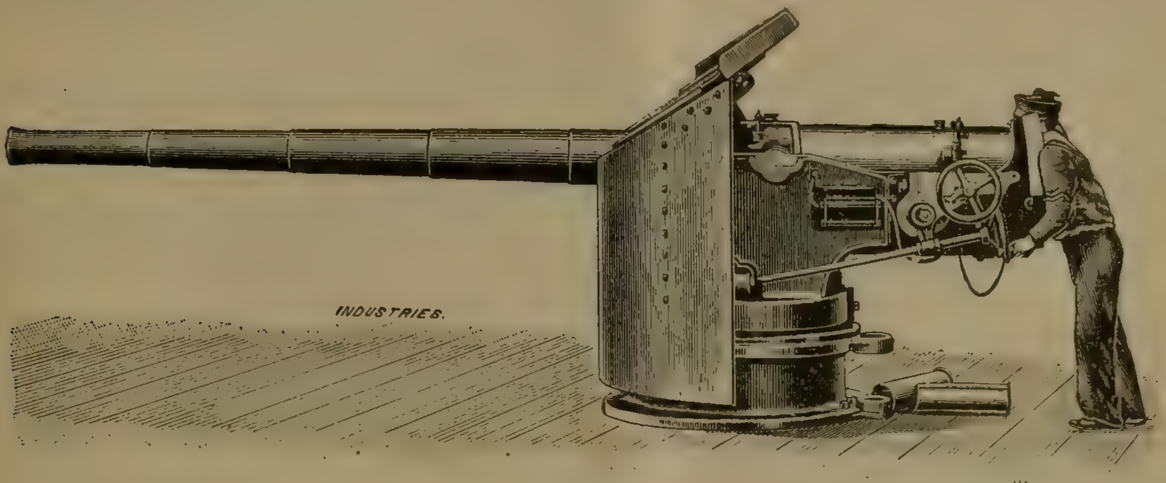
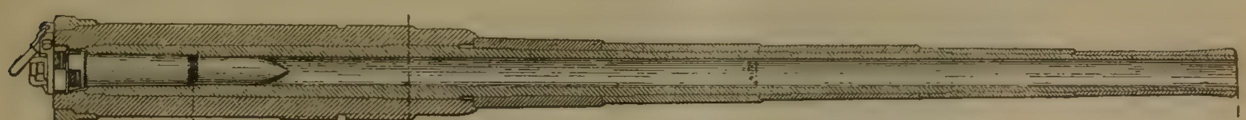



Fig. 1.

THE ARMSTRONG RAPID-FIRE GUN.

These guns, which are the latest product of the Elswick Works, differ from the Nordenfeldt, the Gatling, and other machine guns, in being loaded by hand, in having only one barrel, and generally in being larger in size. The quick-firing or rapid-fire gun differs from an ordinary gun by having special breech mechanism, and particularly by the use of cartridge cases, which are generally made of brass or gun-metal, composed of two or more pieces screwed or riveted together, or solid-drawn out of one piece. One of these cartridge cases constructed in the latter manner, which has been fired twenty times in a 4.7-in. quick-firing gun, is exhibited to show how successfully they are constructed. After each time of firing these cartridge cases are re-formed, for which purpose special tools are provided.

Fig. 3



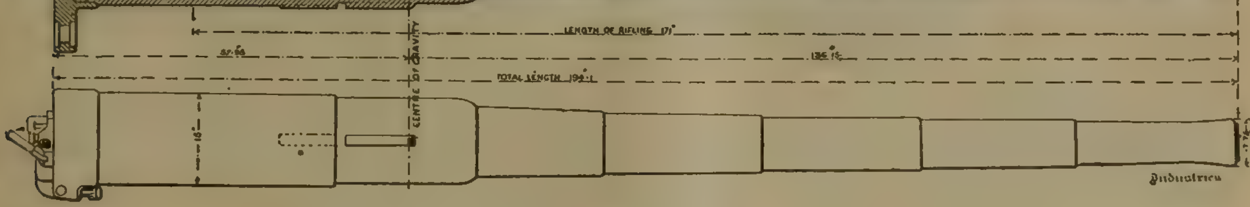



Fig. 2.

The first quick-firing guns were made to fire 3-lb. and 6-lb. projectiles at the rate of 20 to 30 per minute under favorable conditions. Since then guns of this type have been constructed to discharge projectiles of 10 lbs., 12 lbs., 25 lbs., 30 lbs., 45 lbs., 70 lbs., and 100 lbs. The 12-cm. (4.7-in.) quick-firing gun has, however, been so far the most largely adopted of the larger sizes. Originally introduced as a 30-pounder, it was submitted to the Admiralty (in 1886), and most exhaustively tried at Portsmouth. These trials resulted in some slight modifications to the gun, which was finally adopted by the Navy as a 45-pounder. Ever since the Elswick Company have found it difficult to manufacture this weapon with sufficient rapidity to cope with the demand, and there still appears every probability of the quick-firing type being more extensively adopted. Interesting trials have been carried out by the Admiralty, in order to compare the rates of firing of the new 4.7-in. quick-firing gun and the 5-in. breech-loading service gun. Both these weapons were mounted in gunboats, and fired under precisely similar conditions, the result being that the 4.7-in. gun fired 10 rounds in 47 seconds, and the 5-in. gun took 5 minutes 7 seconds to fire an equal number. Evidently it is only a question of time and money for the complete superseding of the ordinary service gun by the rapid firer. Besides having the advantage of firing six times as often, the latter has the further advantage that between each discharge but a slight alteration in aim is required.

Noteworthy among many improvements, introduced to insure rapid loading and firing, is the Elswick breech screw. It is on the principle of the interrupted screw, but is made of a coned instead of a cylindrical shape. This arrangement secures two advantages, first, the action of opening and closing the breech is much simplified, as the breech screw need not be withdrawn before hinging away; and, second, the coned shape of the breech screw enables it to take hold, not only of the inner surface of the metal of the breech hoop or jacket, but also distributes the engagement, and, therefore, the strain and support, over a much larger surface. The breech-screw is further arranged so that the threads of the smaller end of the cone correspond longitudinally with the interrupted spaces of the larger end, and *vice versâ*, so that the strain and support are also distributed throughout the entire circumference of the breech-screw, instead of, as formerly,

half the circumference being lost by the interrupted spaces.

Electricity is used as the means of firing these guns with advantage, as electric primers can be kept in the loaded cartridge cases without the slightest danger. An explosion would be so serious that percussion primers would never be tolerated in the cartridge cases, except just before firing, however unlikely accidental explosion might be considered. Further, the use of electricity

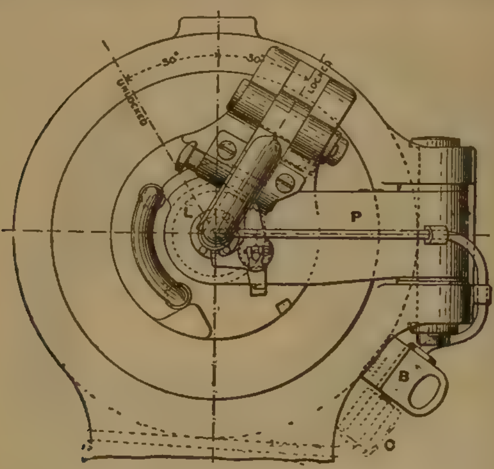


Fig. 4.

facilitates arrangements to secure the guns being in proper firing position when fired—especially necessary, seeing that the rapidity of firing is very liable to lead the gunners to omit some of the routine of their work. To obviate failure, the electric light is always supplied in duplicate, and sometimes even a third current is provided, and percussion firing can also as a last resort be substituted with barely a moment's pause.

An ingenious electric sounder has been devised to assist in providing against miss-fires, and can be seen in action in the Exhibition. It commences to ring, if every-

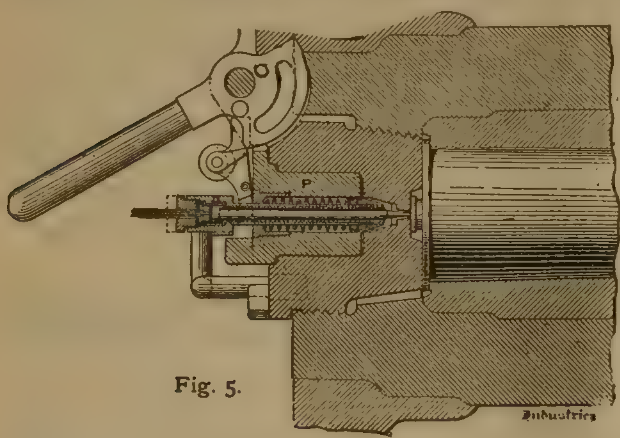


Fig. 5.

thing is in order, directly the gun is loaded and in the firing position. By its means all the primers can be tested before actually required for firing, and further it has the merit of being free from complication. Considerable attention has naturally been given to providing a suitable mounting for these guns. Instead of being fitted with trunnions they are placed in cradles, keys being provided on the guns, which, working in keyways in the cradle, prevent the gun from turning. The breech of the gun is fitted with a horn, which is connected with a piston-rod working in the recoil press cylinder under the cradle. Two steel rods are also attached to the horn on the gun, and, passing each side of the recoil cylinder, are connected with a spiral spring which causes the gun to return to the firing position after absorbing the recoil energy. On the cradle are trunnions which fit into bearings in the sides of the carriage. The latter are cast steel, and are bolted to the upper roller path and to the 3-in. vertical shield which forms the front part of the mounting. The upper roller path is stamped into form by hydraulic pressure. It runs on 24 rollers, provided with flanges on the interior edges, and kept in place by a circular ring, each roller working on to an axis bolted on to the ring. Thus the resistance offered by friction is minimized, and the training of the gun we illustrate can be effected with ease by a push, although gearing is provided. Elevation is obtained by a hand-wheel geared into the elevating arc fitted to the cradle, placed so that it can be used with the left hand while the eye is on the sights, the right hand on the firing pistol, and the left shoulder pressed against the shoulder piece, so that one man can train, elevate, fire, and sight the gun simultaneously.

## THE MAXIM FLYING MACHINE.

REFERENCE has been made heretofore to the flying machine on which Mr. Hiram S. Maxim, the inventor of the Maxim gun, has been at work for some time. Below we give his own account of the machine, the extracts being from a long interview published recently in the New York *Sun*.

My experiments have not been in the realm of ballooning, but on the aeroplane system—to propel a plane set at an angle so as to ride on the air as fast as the air yields, and so to keep up an approximately straight course.

I put up a steel column, with a long wooden arm arranged to rotate on top of the column; an arm pivoted to the column, simply to swing around and long enough to describe a circle exactly 200 ft. in circumference. This arm was stayed in every direction so as to be perfectly stiff, and it was as sharp as a knife, so as to offer very little resistance to the air. To the end of this arm I attached what might be called a small flying machine, arranged in such a manner that power could be transmitted to the machine through the post and arm.

The machine had a steel shaft that could be rotated at any speed, and was also provided with a dynamometer, an instrument for measuring force. To this shaft of the flying machine were attached various kinds of propeller screws—one at a time—which I caused to be rotated at various speeds. The apparatus when complete was arranged to correctly indicate the number of turns per minute, the actual push or propelling force of the screw and the slip of the screw. When the arm was allowed to go free and the screw was rotated at a high speed, the flying machine would travel around the circle at from 30 to 90 miles an hour.

The machine was also provided with a system of levers similar to those used in ordinary druggist's scales, and to this were attached planes, generally made of wood and arranged in such a manner that they could be placed at any angle above the horizontal. By carefully measuring the power required for a certain speed without any plane attached, and then attaching the plane and running the machine at exactly the same speed, the difference in the force required for both operations indicated the actual force required to propel the plane.

The apparatus for holding the plane was provided with a carefully made dynamometer, which measured and registered the lift of the plane—the amount it would lift when being driven through the air. When these planes were perfectly horizontal and the machine was allowed to travel at a high velocity nothing was registered, but if the front or advancing edge of the plane was raised slightly above the horizontal—say 1 in 30—then it was found to have a tendency to rise. On one occasion, when a plane was placed at an angle of 1 in 25, it was found that it would carry 250 lbs. to the H.P., but this result was only obtained on one occasion. The angle was so slight and the speed was so high that it was difficult to arrive at the same result the second time on account of the trembling of the plane in the air. The angle was accordingly changed, and nearly all subsequent experiments were tried with the plane placed at an angle of 1 in 14—that is, that when the plane advanced 14 ft. it pressed the air down 1 ft.

In these experiments it was found that with every pound of push given by the screw 14 lbs. could be carried by

the plane. The skin friction on the screw and on the plane was so small as to be unappreciable; it was nothing like the friction of a screw in the water. With the angle of 1 in 14 everything ran smoothly, and experiments were tried with all speeds between 20 miles and 90 miles an hour. These experiments proved that certainly as much as 133 lbs. could be carried with the expense of 1 H.P. These are the data I personally obtained, and which I know to be true. They do not depend on theory at all. The small planes experimented with were from 2 ft. to 13 ft. long and from 6 in. to 4 ft. wide. Fifty different forms of screws or screw propellers were used in conducting these experiments. . . . . . My large apparatus is provided with a plane 110 ft. long and 40 ft. wide, made of a frame of steel tubes covered with silk. Other smaller planes attached to this make up a surface of 5,500 sq. ft. There is one great central plane, and to this are hinged various other planes, very much smaller, which are used for keeping the equilibrium correct and for keeping the flying machine at a fixed angle in the air. The whole apparatus, including the steering gear, is 145 ft. long. The machine is provided with two compound engines, each weighing 300 lbs. The steam generator weighs 350 lbs. The other things—the casing about the generator, the pump, the steam pipes, the burner, the propellers, and the shafting —all weigh 1,800 lbs. Everything is remarkably light, so remarkably light that one grate-bar in a boiler that generates as much steam as mine would weigh more than my

whole boiler. It is made of copper and steel brazed with silver solder. There are 48,000 brazed joints in the generator, and it is heated by 45,000 gas gets, there being 40 ft. of grate surface. The heat thus produced is perfectly terrific. The boiler was tested up to 900 lbs. pressure, and it didn't leak a drop.

The most novel feature about the engine is the system by which I burn petroleum and generate steam. Petroleum is turned into gas, and then that is burned for generating steam. The engines have lately been tried, and it was found that they gave a push of 1,000 lbs. on the machine, which seems to indicate that the machine will carry 14,000 lbs. The actual amount of power shown in useful effect upon the machine itself was 120 H.P. A part of the Aeroplane, or actual kite, is made of very thin metal, and serves as a very efficient condenser for the steam.

It looks much like a kite . . . . indeed, that is what it is —a huge kite, with the machinery hanging beneath it from its under side. If it were in the air, in flight, you would see a great sheet of silk and a little platform under it, between it and the earth.

The machine has not been tried, owing to my absence from England. It is ready and awaiting my return. It is now resting on a track 12 ft. wide and half a mile long, in my park. The first quarter of a mile of the track is double—that is to say, the upper track is 3 in. above the lower. By that means I am able to observe and measure the lift of the machine when it starts, because the upper track will hold it down when it lifts off the lower one. When completed the machine will weigh, with water tanks and fuel, somewhere between 5,000 and 6,000 lbs., and the power at my disposal will be 300 H.P. in case I wish to use it, but it is expected that about 40 H.P. will suffice after the machine has once been started, and that the consumption of fuel will be from 40 to 50 lbs. per hour. The machine is made with its present great length so as to give a man time to think; its length makes it easier to steer and to change its angle in the air. Its quantity of power is so enormously great in proportion to its weight that it will quickly get its speed. It will rise in the air like a seagull if the engine be run at full speed while the machine is held fast to the track and if it is then suddenly loosened and let go. If it were necessary, it could mount right up, spirally, around and around in a circle of a mile in circumference, in its own country.

If it proves as I have figured it, there should be room for fuel to carry it 1,000 miles; indeed, it looks as if it might carry two tons of fuel, or sufficient to propel it across the ocean. But I cannot tell about that; a trial alone will determine what unforeseen things, not calculated, will arise. It will be possible to burn 200 lbs. of fuel an hour, but I figure that 40 or 50 lbs. will produce a moderate speed, or for high speed, 100 lbs. The highest speed I got on the small machine was 90 miles an hour, but I believe this big one will go 100 miles an hour.

If it goes at all I shall be very happy, but on the basis of my figuring it ought to be able to develop between 250 and 300 H.P., and it ought to carry 9,000 lbs., or 1,400 lbs. with its own weight included. In warfare it will not need to carry so very much. Two men will be enough—two men and a little dynamite—a ton or a couple of tons.

As to wind, the winds are as apt to be favorable as unfavorable, but at a certain distance from the earth they cease to be formidable. You are always in a dead calm at a certain distance on high. Gales are narrow things; they don't disturb much space. Moreover, their strength and speed have been very much exaggerated in the popular mind. Let us suppose we are encountering a wind at 40 miles an hour—a very unusual speed—then if the machine is regulated to go 60 miles an hour, it will travel 20 miles against the wind, or 100 miles with it. . . .

As to what it will do, the whole world becomes changed if it works—the whole world will be revolutionized in a year. There will be no more iron clads, no more armor plates, no more big guns, no more fortifications, no more armies. There will be no way of guarding against what this machine will do.

## RAPID TRANSIT IN NEW YORK.

THE conclusions reached by the Commission which has been considering the question of additional rapid transit lines in New York were finally given to the public in the following resolutions adopted. These refer to the west side of the city only; plans for the east side were to be considered later.

*Resolved*, That after a thorough investigation, it is the sense of this Board that any additional rapid transit system for the city of New York should embrace the following essential features:

1. That it should be such as to provide not only for present needs, but also be susceptible, by additions and not by radical changes or alterations, of such expansion as the future growth of the city may require.
2. That it should provide for express trains at high speed for long distances, and for way service for intermediate distances, upon separate tracks, so located as to facilitate at proper intervals an exchange from express to local and from local to express trains.
3. That the surface of the streets and avenues in the city should be obstructed to the least possible extent, and that whenever surface ground is required private instead of public property should be used if practicable.
4. That the first lines of railroad to be constructed should be on or near the important thoroughfares coincident—or as nearly so as possible—with the main arteries of travel.

*Resolved*, That as meeting these requirements in the manner most feasible for the west side of the city, this Board hereby approves of a plan for an underground four-track railroad under Broadway from a point at or near South Ferry to 59th Street; thence under the Boulevard to a point at or near 169th Street, with such length of viaduct at and near Manhattan Street as may be necessary; thence under Eleventh Avenue, or under private property immediately to the west thereof, as may be found most convenient to such point as the contour of the ground may

PASSENGER LOCOMOTIVE, DELAWARE, LACKAWANNA & WESTERN RAILROAD.

BUILT AT THE SHOPS AT KINGSLAND, N. J. W. H. LEWIS, MASTER MECHANIC.

determine; thence by viaduct across Spuyten Duyvil Creek, and by tunnel or by viaduct to the city limits.

*Resolved*, That the general plan of construction from, at or near South Ferry to near 42d Street shall be either by double-decked tunnel, with two tracks upon each deck or four tracks on the same level, as may be found upon examination or survey most expedient; the hole to be at such depth below the curb line as not to disturb the surface or endanger building foundations; from near 42d Street north to be four parallel tracks upon the same level; as near the surface of the street as practicable when in tunnel, but not in open cut at any point.

*Resolved*, That the stations for such line of railroad shall be upon property acquired for the purpose, and shall be provided with ample elevator capacity wherever the platforms shall be 20 ft. or more below the curb line.

*Resolved*, That the motive power for such railroad shall be electricity or some other power not requiring combustion within the tunnel.

*Resolved*, That the engineers of the Board be and are hereby instructed to make the necessary surveys and prepare in detail the plans and specifications for such railway, and submit the same promptly to this Board for its further action in finally determining a general plan for submission to the Common Council in accordance with the provisions of the Rapid Transit act of January 31, 1891.

## A NEW EXPRESS LOCOMOTIVE.

THE accompanying illustration is from a photograph of a new passenger locomotive recently completed at the shops of the Morris & Essex Division of the Delaware, Lackawanna & Western Railroad at Kingsland, N. J. The engine was built from the designs of Mr. W. H. Lewis, Master Mechanic of the Division, and under his supervision.

The work done by the passenger engines on this road is excellent, and not by any means easy. On the through or express trains they must keep up a high speed over a line having numerous curves and some very steep grades, while on the local trains they have to haul frequently 8 and 10 cars, with stops at intervals of one or two miles.

The engine shown is of the eight-wheel type, and burns anthracite coal. It is now regularly at work in express service.

The boiler is of steel throughout, and is 54 in. in diameter at the smallest course. The barrel, outside fire-box and back sheets are $\frac{7}{16}$ in. thick; the smoke-box and smoke-box tube-plate are $\frac{1}{2}$ in. There are 200 tubes, 2 in. diameter and 11 ft. $5\frac{5}{8}$ in. long. The fire-box is 10 ft. long and 42 in. wide inside; the side, back and front sheets are $\frac{5}{16}$ in. thick, the crown-sheet $\frac{3}{8}$ in. and the tube-sheet $\frac{1}{2}$ in. The grate area is 35 sq. ft. The heating surface is: Fire-box, 137 sq. ft.; tubes, 1,200 sq. ft.; total, 1,337 sq. ft. It will be seen that Mr. Lewis does not use the extended smoke-box.

The driving-wheels are 69 in. outside diameter, the centers being 62 in. and the tires $3\frac{1}{2}$ in. thick. The driving-axles are of steel and have journals 8 in. in diameter and $9\frac{1}{2}$ in. long. The driving boxes have hangers for under-hung springs. The truck wheels are 33 in. in diameter. The drivers are 8 ft. apart between centers, and the total wheel-base of the engine is 22 ft. $4\frac{1}{2}$ in.

The cylinders are $18\frac{1}{2}$ in. in diameter and 24 in. stroke. The Richardson-Allen valve is used. The guides are of the Dean pattern, as shown by the engraving.

The engine has the Westinghouse improved automatic driver and tender brake; it is equipped with the Rushforth feed-water heater and circulator and has two No. 9 monitor injectors. It is also provided with steam heating attachments.

The tender is carried on eight 36-in. wheels; the tank has a capacity of 3,200 gallons, and the coal box will carry four tons of coal. The weight of the tender, empty, is 32,460 lbs. The total wheel-base of engine and tender is 47 ft. $6\frac{1}{2}$ in.

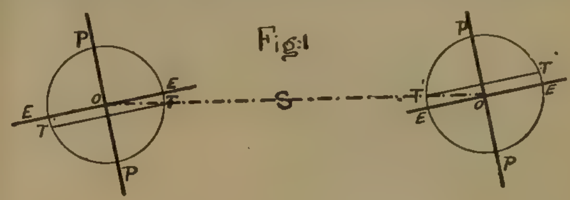
The weight of the engine in working order is 106,000 lbs., of which 74,455 lbs. are carried on the driving-wheels, and 31,545 lbs. on the truck.

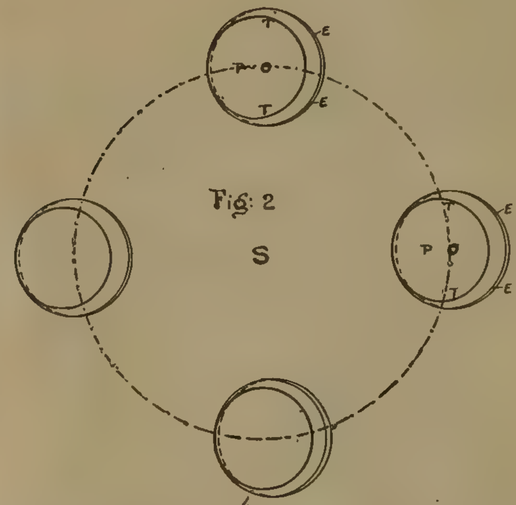
## SUNDIALS FOR LOW LATITUDES.

By George L. Cumine, C.E.

THE design of a dial for any given latitude must be based on a knowledge of the relative positions of the sun and the earth throughout the year; that knowledge possessed, designing a dial is a process of simple projection, like the preparation of an ordinary working drawing in elevation and plan; and the accuracy of the more important dimensions can be checked by means of equally simple processes in plane trigonometry.

Figs. 1 and 2 are respectively an elevation and plan of the plane in which the earth makes its annual circuit (in the figures *proportion* is necessarily disregarded); *S* represents the sun; in fig. 1 the earth appears at midwinter and midsummer, when the axis *P P*—about which it makes its daily revolution—lies in a plane bisecting the sun



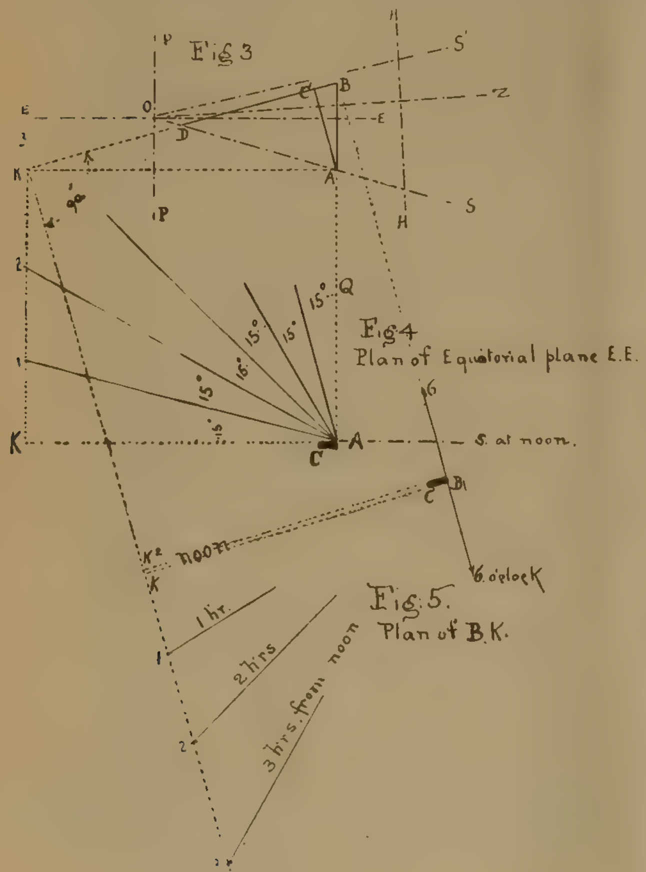

and perpendicular to the plane of annual circuit; at these periods the angle $E\ O\ T = 23°\ 27'$—approximately—and is at its maximum; obviously at all other times it is less, and in the two other positions shown in fig. 2 it becomes zero, the equatorial plane *E E* coinciding with the line *S O*.

The two circles *T*, *T′*, each in latitude 23° 27′, limit the tropics within which all parts of the earth's surface are in turn subjected to vertical rays from the sun; thus in fig. 1 the sun's rays strike vertically on one limit of the tropics in the left-hand view of earth, and on the other limit in the right-hand view.

An ordinary sundial consists of a triangular plate—called the "style" or "gnomon"—set in a vertical plane, with its upper edge parallel to the earth's axis, and a plane face, to which the style is rigidly attached, so graduated that the shadows successively cast by the upper edge of the style on the graduations indicate solar time. The corrections by which "solar time" may be reduced to "mean time," or that in every-day use, are to be found in almost every almanac, frequently appearing under the headings "sun slow" and "sun fast." On the angle made by the dial face with the horizon, and the relative sizes of the style and face, depends the suitability of the dial to its position, while the truth of its indications is a result not only of precisely correct construction and graduation, but of correct setting of the whole dial in position.

Suppose a dial to be required for latitude 5° N. In fig. 3, as before, *P P* represents the earth's axis and *E E* the

equatorial plane; $O\,Z$ is the vertical passing through the point at which the dial is to be set, and making an angle with $E\,E$ of 5°. $H\,H$ perpendicular to $O\,Z$ is the horizontal. Draw $A\,B$ parallel to $P\,P$ to represent the upper edge of the style. Draw $O\,S$, $O\,S'$, making the angles $E\,O\,S$, $E\,O\,S'$ each equal to 23° 27′, so that $S'\,S$ represents the extreme northern and southern positions of the sun; plainly, a dial face set so near the vertical as to stand inside the angle $S\,O\,S'$ will, during a part of the year, have the sun on its back, its face in shadow and consequently be for a time useless. Again, a little consideration will show that a horizontal dial face will be so nearly parallel to the style-edge that the style will be diminutive, casting disproportionately small shadows for three hours each way from noon. Therefore, draw $B\,D$, making an angle of 24° with $E\,E$, to represent a dial face as nearly vertical as is consistent with daily illumination throughout the year;




the length of the face, $B\,D$, should be at least such that $S\,O$ cuts $D$, when $A$ lies in $S\,O$, as in the figure. Now erase all lines and marks but $D\,B$, $B\,A$, and retaining the relative proportions and positions of these, produce them to fit a good working scale, say full, or, for a large dial, half-size. Draw $A\,C$ perpendicular (this is customary and convenient, but not necessary) to $B\,D$; then $A\,C\,B$ is the style. Now project the inverted view, fig. 4, and produce one side of $A\,C$ to $K$, projected from where, in fig. 3, $A\,K$ perpendicular to $A\,B$ intersects $B\,D$ produced. Divide the quadrant $K\,A\,Q$, fig. 4, into six equal angles of 15° each, the dividing lines being extended to cut $K\,K$ at 1, 2, 3, 4, 5; notice that these lines represent hourly shadows, as the earth makes one quarter-revolution. Now project—again from fig. 3—the plan shown in fig. 5; producing $B\,C$ to $K$ and laying off, perpendicular to $C\,K$, the distances $K\,1$, $K\,2$, $K\,3$, $K\,4$, $K\,5$ obtained from fig. 4; draw radiating lines connecting these points with $B$, when half the dial-face will be divided for five hours from noon. If, now, a parallel line to $B\,K$ be drawn, distant from it the thickness of the style, five hours on the other side of noon may be similarly laid off from the newly found point $K\,2$. Finally, a perpendicular to $B\,K$, drawn through $B$, will give the six o'clock lines, morning and evening. The hours may be subdivided as much as desired in a similar manner; thus, for quarter hours, the quadrant in fig. 4 would be divided into arcs of $\frac{90°}{6 \times 4} = 3°\ 45'$ each.

Practically, for a large dial, it is best to compute the distances necessary for graduation and lay them carefully out to scale. The formulæ are, calling the style—angle $C\,B\,A$ in fig. 3—$B$:

$A\,K = \tan.\ B \times A\,B.$ $\qquad$ $B\,K = \sec.\ B \times A\,B.$

$$\begin{cases} K\,1 = \tan.\ 15° \times A\,K. \\ K\,a = \tan.\ (15 \times a)° \times A\,K. \\ K\,5 = \tan.\ 75° \times A\,K. \end{cases}$$

The division lines having been laid down full size on a sheet of paper, a line parallel to and an inch or more inside of the intended edge of the dial-face may be drawn and the divisions pricked through thereon. Notice that while this sheet must be full size, the projections—still necessary for determining the arrangement and proportions of the dial—may be to any convenient scale.

In construction care must be taken to fix the style exactly perpendicular to and with its indicating edge at the proper

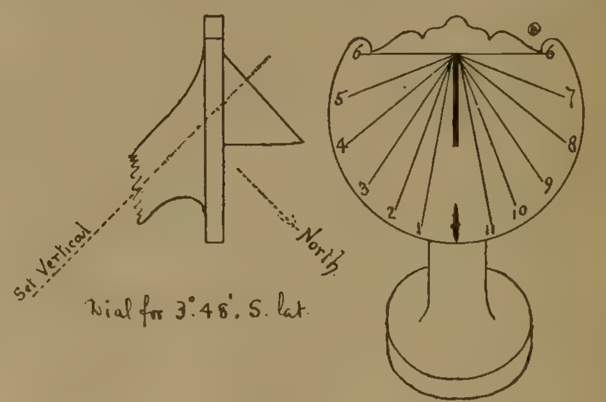



Fig. 6.

angle with the dial-face. And in setting a dial the six hours' line must be levelled, the face put at the proper angle with the horizontal, turned *southward* in *north* latitude, and *vice versa*, and the plane in which the style lies must be *truly* north and south.

The dial-face illustrated in fig. 6 is designed to make an angle of 45° with the horizon in latitude 3° 50′ south; the lessening of the hour-angles toward noon would be much more conspicuous in a horizontal dial, while it would be imperceptible in one making only 21° with the vertical, which would be the steepest pitch practicable in this case. In fig. 3 the dial-face makes an angle of 24° with $E\,E$, and consequently of 19° with the vertical, the latitude being 5°.

Within the tropics the minimum admissible angle for a dial-face to make with the vertical is 23° 27′ minus the latitude.

Adaptations of figs. 3, 4 and 5 will serve to ascertain the best arrangement of dial for any latitude. It must be understood that the account given above of the motion and inclination of the earth, although correct, is not precise; as a matter of fact the obliquity of the ecliptic, given above as 23° 27′, is continually changing, its present rate of annual diminution being rather less than half a second.

Wooden sundials are liable to warp; stone and metal ones require special appliances not always available for their manufacture. Where cement can be had excellent dials can be moulded, care being required, however, not to use a dry wood mould, otherwise it will absorb the water from the cement, becoming warped itself and leaving the cement with a crumbling surface. The mould, if of timber, should be thoroughly soaked before being filled, and then, if Portland cement is used, re-immersed in water, as the cement sets best when kept wet. A graceful and lasting monolith can be produced in this manner.

## EXPERIMENTS WITH A STEEL CRANK-SHAFT.

(Paper by H. A. Ivatt, before the Institute of Civil Engineers of Ireland; published in the *Practical Engineer*.)

Almost all failures of steel axles begin with a crack, and it is well known that a crack once started in a steel axle will continue to extend—if the axle be kept at work—until it finally goes right through; that is, until the axle breaks; and interesting questions arise as to the original cause of the crack or flaw, as to the method or frequency of examination; also, perhaps, the question may arise as to whether a given crack is sufficient to condemn an axle. Various methods of strengthening axles have been proposed, the one most generally adopted being that known as hooping, which, as the term implies, is done by shrinking wrought-iron hoops over each of the sweeps or throws of the crank. The author believes that there would be practically no limit to the life of a steel crank axle, of proper dimensions, if it could be kept from developing a crack.

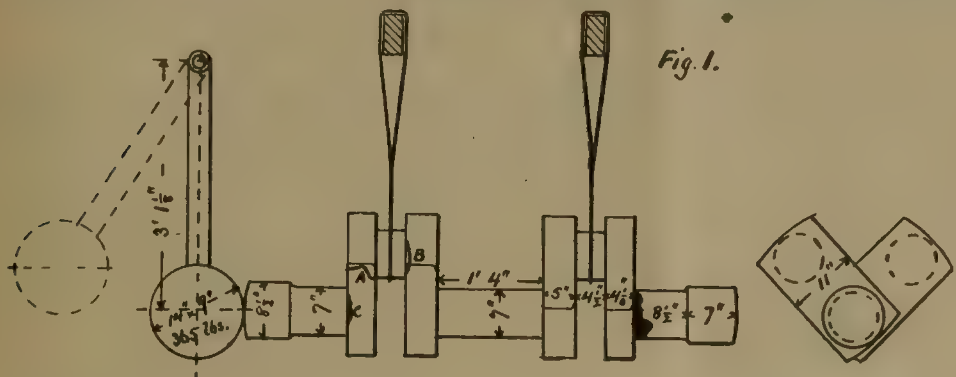



Fig. 1.

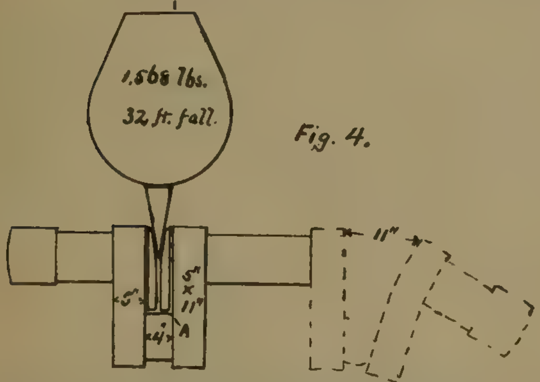



Fig. 4.

This is rather like asserting that a man might be expected to live a very long time if he never contracted any disease. But what is meant is that the weak point about steel crank axles is their liability to start a crack, and a crack once started is practically impossible to stop; if any method could be devised whereby the starting of a crack could be prevented, then the life of the axle would be indefinitely prolonged. There is no doubt that if the crack could be seen directly it commenced, and could be at once cut out, the axle—although weakened in sectional area by the cutting out—would last much longer than it would have done if the crack had been allowed to go on. Steel being homogeneous, there is nothing in the formation of the material to arrest a crack, but the crack goes on just as it does in a sheet of glass or a lamp globe. The author, believing that vibration alone would cause a crack in a steel axle to extend quite as rapidly as it would under the strains due to ordinary working, tried the following experiment: A steel crank axle, which had been withdrawn from service on account of a crack—more fully described below—was suspended by sling-chains round the crank-pin bearings, and in this position was subjected to blows on the end from a hanging weight, as shown in fig. 1. The weight was 365 lbs., and was hung on a lever about 3 ft. long. The lever was drawn back and let go by means of a cam, worked from the shop shafting, and gave a blow on the end of the crank axle of about 182 foot-pounds. The chains in which the axle hung were about 2 ft. 6 in. long, and the axle weighed 2,016 lbs. The blows averaged about 3.6 per minute, the effect being to keep the axle in a state of vibration, and the end of the axle finally dropped off where marked *B* after 645,300 blows had been delivered. The axle used in this experiment was forged by Messrs. Vickers, of their best steel, and finished at Inchicore. The following are its leading dimensions:

| | |
|---|---|
| Diameter at wheel seats | 8½ in. |
| Diameter of bearings | 7 in. |
| Diameter of crank-pin bearings | 7 in. |
| Thickness of outside webs | 4⅜ in. |
| Thickness of inside webs | 5 in. |
| Diameter of axle between cranks | 7 in. |
| Length of stroke | 24 in. |

It was at work under a six-wheeled coupled yard engine, having wheels of 4 ft. 6 in. diameter and had run some 176,327 miles. The axle was found to be cracked at *A* on being subjected to the usual examination when the engine was under repair. In consequence of the crack it was condemned and replaced by a new axle. The crack extended about 4 in. along the fillet of the crank-pin, and was then probably about ½ in. or ⅝ in. deep, and no other crack was visible at that time. It will be noticed that this crack at *A* is not the place where the axle afterward broke.


Fig. 2

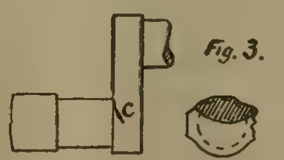



Fig. 3.

The crack at *B*, where the breakage eventually took place, began to show about three or four months after the experiment commenced, or after the axle had received some 180,000 blows. The crack at *C* was discovered about two months before the end of the axle dropped off. The original crack extended about ⅜ in. during the first three weeks of the experiment and about ⅛ in. during the next four weeks; it then remained about the same for some months, and the principal action then seemed to go on in crack *B*. After the axle had broken at *B* by vibration, it was forcibly broken through cracks *A* and *C*, and the shaded parts on figs. 2 and 3 show the extent to which these cracks had grown. The state of vibration into which the axle was thrown by the blows on the end was evidently more trying, at any rate in the direction of developing cracks, than the strains to which it was subjected when at work. The axle was suspended, and the blow was not sufficiently severe to cause any undue strain; probably the actual strain on the material in the neighborhood of the cracks caused by the blow itself (apart from the resulting vibration) was very far short of the strain to which it would have been subjected at every revolution if it had been at work under the engine. When at work the axle carried a load of about six tons on each bearing, and had to transmit the work done by a pair of 18-in. cylinders, with a steam pressure of 140 lbs. It had also to withstand the pinching action which takes place between the rails and flanges, particularly on curves, and which action is specially severe on a crank axle; and yet the author believes that if this axle had been allowed to continue at work it would not have broken in so short a time as it did under the treatment it received in the experiment.

The axle—as mentioned above—broke after 645,300 blows, which took 2,673 hours to deliver—that is, the experiment lasted about one year, at the rate of ordinary

shop hours of 54 per week. If the axle had been at work, it would have run some 20,000 miles during 12 months on the kind of work at which the engine was employed, and in that time the axle would have made nearly 7,500,000 revolutions. It is believed that the effect of the vibrations resulting from each blow was much more severe on the axle than the injury it would receive from each revolution if at work. If we assume that each blow in the experiment only affected the axle to the same extent as each revolution would have affected it, then if allowed to go on working it would have broken after 645,300 more revolutions, or less than an additional 1,500 miles. It is difficult to speak with any certainty upon the subject, and it is of course impossible to test the same axle to destruction by each of two different methods, but a considerable experience in flaws developed by crank axles leads the author to believe that this particular axle would have run many more miles than 1,500 before it broke at the crack *A*, and the experiment seems to show that the effect of vibration is more trying to a steel axle—particularly in the direction of starting or extending cracks—than the ordinary working strains. In order to ascertain whether the material near the cracks was of good quality, test pieces were cut from the crank sweep; these gave a tensile strain of 24.4 tons per square inch, with 36 per cent. of elongation in 8 in., showing that the steel was soft and good, and that it had not suffered from the vibration to which it had been subjected.

The author does not believe that steel axles change or become crystallized under long-continued vibration; hence the remark above as to the life of an axle being indefinitely prolonged if the starting of cracks could be prevented. The result given by the test pieces, cut from near the worst crack in the axle experimented upon, indicates that no change had taken place; and a comparison of the fracture of a steel crank axle which has run a great many miles with that of one which has done very little work will reveal no difference in the appearance of the material; but if we examine the fracture of a wrought-iron axle which has been at work for some years, we shall probably find a great deal of the fractured surface covered with large crystals; but this does not prove that the crystals were not there when the axle was new.

Following up this subject, fig. 4 shows the result of wedging open the sweeps of another steel crank axle, of the same material and by the same makes, which had been removed from work after running 207,400 miles in consequence of a crack developing at *A*. The arrangement of wedge and tup used is shown in the sketch. The tup weighed 1,568 lbs., and had a fall of 32 ft. The crack in this case was only ¾ in. long and ⅛ in. deep, and yet the crank in which the crack was broke right off at the first blow; while the other crank on the same axle stood ten blows and opened 7 in.—as shown in fig. 4—without breaking, showing that the material was wonderfully sound and tough, and had in no way suffered by the work it had done in running 207,400 miles.

It is difficult to account for the commencement of a crack in a steel axle. No doubt, an air bubble in the ingot from which the axle was forged would account for a crack; but it is possible that cracks may start from less obvious causes than air bubbles or other defects in the original ingots. It may be that a scratch from a file or lathe tool, or from a piece of grit in the bearing, is sometimes sufficient to start a crack, in the same way that a diamond starts a crack in a sheet of glass. That this may be so seems at least possible, when we consider that, in cutting out a crack, if the smallest part of the crack be left it will gradually increase and extend; and an injury to the skin of the metal, such as is called a scratch, may, under certain conditions, be in the form of an incipient crack. In cutting glass with a diamond, the cut made when the diamond is properly held is really the crack and not a scratch; it is, in other words, a forcing apart of the material, leaving an unfinished tear, which is ready to extend right through when strained sufficiently.

The author regrets that his experiment does not do more than help to show the effect of vibration. If it had been suspected that cracks would start at *B* and *C*, in addition to the one known to exist at *A*, then a more careful examination of the surface of the metal at those places would have been made; but an experiment of the kind takes a long time to carry out, and a crank axle weighing 2,000 lbs. cannot be turned over and examined frequently without considerable trouble. If there may be any truth in the suggestion that cracks may arise from surface damage as distinct from inherent flaws, then no doubt precautions could be taken to prevent such damage, and perhaps some method of treatment analogous to burnishing the surface of the metal might be of advantage. The idea that cracks in steel shafts may start from some kinds of apparently trifling surface damage may be regarded as being rather far-fetched, and yet, on the other hand, it is borne out by the fact that cracks have been known to start from the corners of small key-seats cut in steel axles. A great deal remains to be discovered as to the exact causes of the failure of steel under different circumstances, and the above-mentioned experiment is noted as bearing upon one branch of the subject.

## THE SAULT STE. MARIE LOCK.

THE illustration of the plan and location for the new lock at the Sault Ste. Marie is from the Cleveland *Marine Review*; it is the first that has been published, and the following particulars were furnished by Lieutenant Riche. From quoin-post to quoin-post the new lock will be 800 ft., while the whole length of the walls will be 1,100 ft., the walls being 100 ft. apart. The gates will be of steel instead of wood, and each leaf of the lower and intermediate gates will weigh 150 net tons, while each leaf of the upper and lower guard-gates and the upper gate will weigh 100 tons, 1,200 tons of steel being used for all the leaves. While the new lock will be very much larger than the present one, it will be emptied in about the same time, there being six 8-ft. square emptying tunnels and a like number of filling tunnels. By the following it will be seen that there will be no necessity for miter sill protection. The breast wall at the head of the lock will be 6 in. higher than the lower miter sill and the floor will be 6 in. higher than the lower miter sills; and the miter sills in the new lock will be 6 ft. lower than those in the present lock, giving that much more draft to vessels. There will be used in the masonry work 22,000 barrels Portland and 75,000 barrels natural cement, 20,000 cubic yards cut stone, 59,000 cubic feet of backing and 5,000 cubic yards of concrete. The masonry work is contracted to be finished November 15, 1893.

The *Marine Review* also publishes an interesting interview with General Poe, the Engineer in charge. Regarding the clay bank left by the excavation of the new lock pit, shown by the accompanying illustration, he says: "This wall or connection bank is 700 ft. long and is built in the canal in prolongation westward of the north wall of the present lock. Its stability is reasonably assured, although it is a source of anxiety, because of the possibility of even a slight delay to navigation. It is capable of withstanding the water pressure, but a heavy shock from a vessel might do damage, therefore extreme care and caution is requested from navigators. The cofferdam is a necessary adjunct to the new lock, and the positive necessity of locating a portion of the dam in the canal, the character of the bottom, the impossibility of driving spiles combine to render the work one of difficulty. The bottom of excavation in the new lock is 53 ft. below level of the water in the canal and 35 ft. below level of water at the lower end of lock. The northern slope of the excavation extends to the rapids. The leaks encountered so far have had their origin in the rock formation below the constructed dam. It is improbable that there should be a worse leak than the one that occurred in March, yet this was successfully closed under most adverse circumstances in unfavorable weather, and were a leak of similar volume to occur again, it would not greatly hinder or delay navigation of the present lock. The dam is now stronger than ever and its present strength can be maintained. All that has occurred thus far and all the speculations put forth as to what circumstances might arise during the construction of the new lock were fully dis-

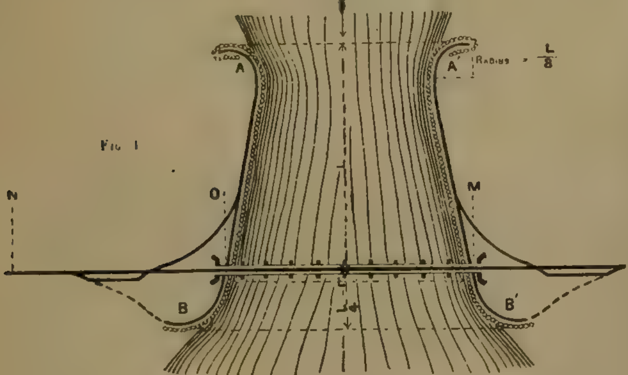
cussed in my report made in 1887. All was foreseen, and the present plan of procedure was adopted as the most safe one for interests concerned. The work cannot be stopped or retarded until winter, for the masonry work can only be prosecuted during warm weather.

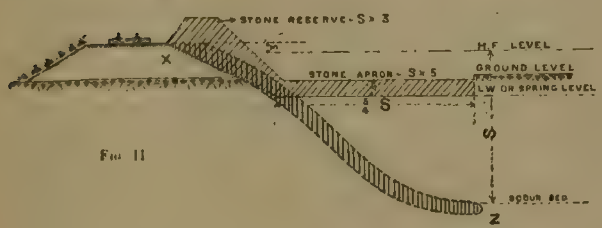
"The chance of a repetition of an accident similar to the one last August has been greatly diminished by replacing the emptying valves and their frames with entirely new ones. The frames of these new valves are of cast iron, like the old ones, but strengthened wherever possible. The new valves, however, are built entirely of steel and wrought iron. The trunnions are of forged steel, tested to a tensile strain of 63,000 lbs. per square inch, 9 in. in diameter, while those of the old valves were of cast iron, of the same diameter, but were hollow, the bore being 6 in. in diameter. The two old emptying valves are held in reserve, and the two filling valves have each been strengthened by passing a 6-in. steel rod through the hollow axis from end to end. Each rod is provided with a massive head at one end and equally massive thread and nuts at the other end, by means of which the requisite strain is put upon them to insure support. It is not intended, however, to depend upon the cast-iron valve frames longer than the present season. New frames are now being built, composed of rolled steel plates united in the form of box girders. They could not be constructed in time to be put into the lock last winter, but will be in their proper position before the opening of another season. They will be more than ten times as strong as the old ones. The pumps have been overhauled, and two more 12-in. centrifugal pumps and two 100 H.P. engines have been ordered."

## RIVER WORK IN INDIA.

A PAPER by James F. Bell, Chief Engineer of the Indian Frontier Railroad, was recently published in the *Indian Engineer*, and will be of interest to engineers engaged in river work in this country, as showing the methods adopted in India. This paper is reprinted herewith.

In the Punjab rivers, which erode their banks and scour their beds deeply on the outer edges of the erosive bends,

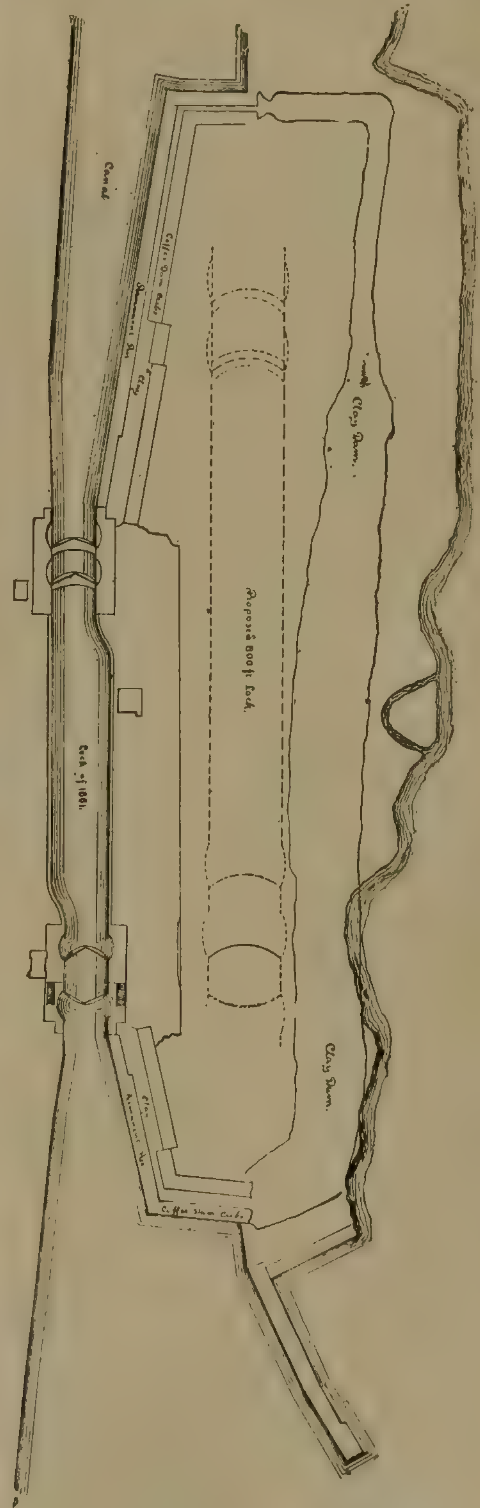



our practice is to retain the stream within a limited length of the bridge by protective *bunds*, faced and aproned with rough stone pitching. In cases where there is no solid ground on which the heads of these flank bunds can rest, we make their length up-stream at least equal to the length of the bridge itself, and extend both of them down stream beyond the abutments to a distance of at least one-fourth the bridge length.

The alignment that is thought best on abstract considerations is sketched in fig. I. In the absence of natural heads those at *A A* are strengthened by very large mounds of stone, in cases as much as 300,000 cub. ft. per

THE OLD AND THE NEW LOCKS, SAULT STE. MARIE CANAL.




head. The extent to which the river should be throated between *A* and *A* depends on the number of piers in the bridge, as these so obstruct and subdivide the channel that a very much narrower width at *A A* gives a much larger effective channel than that afforded by the bridge. The object of the *vena contracta* on plan is to center the

river, and make it fan out equally in all the spans. As a rule the conditions of the site do not admit of using the *vena contracta* ground plan, and it is found that where the bunds diverge on the up-stream side there is a proportionate tendency for an island to form in the middle of the bridge which splits the deep channel toward the abutments. The down-stream tails of the bunds at *B B* are necessary to counteract the eddy that tends to undermine the ground below either abutments.

The cross-section of bund now in vogue is shown in fig. II, and the main factor in determining its proportions is the normal deep scour of an erosive bend referred to as "*S*" in the following portion of this note. This factor is not always easy to ascertain, and should be carefully discriminated from the enormous depths attained in purely alluvial strata by eddies. For example, in the Chenab and Sutlej, eddy-scours of 60 and even 70 ft. below high flood level are known to occur, while 40 ft. is the normal erosive scour (the *S* of the diagram). Where rock is found overlaid by other than firm strata of probably considerable age, the rock is sure, sooner or later, to be scoured clean. At Sukkur the Indus cleans its rocky bed almost every year at 120 ft. below high flood level. The dotted section shows the ultimate position of the apron when scour has engulfed it.

After deciding on the center line of the bund (which should in all cases be at least 20 ft. wide on top, with slopes not steeper than 2 to 1 from 3 ft. above high flood level down to the spring level, at which water is encountered when the river is low) the apron pit is laid out with a width from toe of slope at spring level outward = $\frac{5}{4}$ *S*. The bund is made wholly from the apron pit, and if more earth is wanted it is dug from the river side, as borrow pits in rear of the bund are very objectionable, and liable to induce "blows." Where the apron pit yields more earth than is absolutely requisite the width of bund is increased till they balance. The core of the bund should, if possible, be of fine sand and the slopes of good clay; while the rear slope should be wattled and planted with willows, elephant grass, or other deep-rooted vegetation, as protection against the lap of wavelets that arise on the lake, which forms in rear of the bund by spill or percolation. In the Punjab this lake is purposely filled by a controllable sluice inlet that brings in silt to warp up the lake bed. This process is only effective when a high level outfall draws off the clean upper water and keeps up a steady influx of silt during flood time.

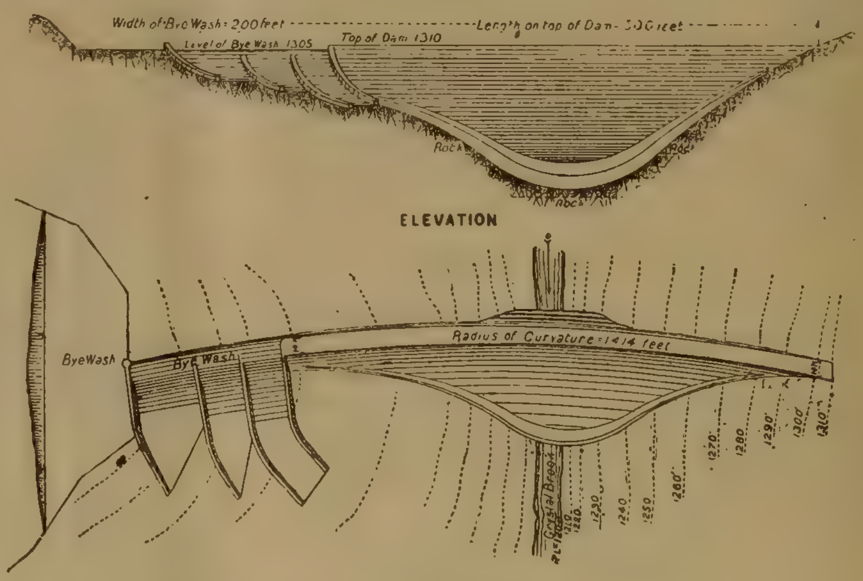
We now invariably lay the apron 4 ft. thick, and hence its cross sectional area = $S \times 5$. The total amount of stone laid in at first = $S \times 8$ and the surplus or reserve = $S \times 3$ is stacked on the river slope of the bund at as steep an angle as it will stand, usually a little steeper than 1 to 1. The top of the bund carries a tramway by which the reserve can be transferred to any point where heavy scour threatens to engulf the reserve stone already in place. During the first three or four years of its existence we think it essential to renew the entire reserve when the river is low, and even to increase it when the indications point to our having underestimated the factor *S*.

Sharp-edged stone is best; and round or even cubical pieces are found wasteful and inefficient. The individual pieces should be of approximately one size, and their weight ought to be the greater as the velocity of the stream increases. For 6 ft. per second average velocity, stones averaging 110 lbs. suffice, if sharp-edged and of high specific gravity, to revet a subaqueous slope as far down as the scour extends. We attribute the success in point of stability and economy that has so far invariably attended this method, as compared with that of stone-faced spurs, to the fact that the latter provoke and intensify *eddy-scours*, while the former tends to eliminate eddies and to straighten out and so minimize the attacks of *bend-scours*.

## A GREAT AUSTRALIAN DAM.

THE accompanying illustrations, from the London *Engineer*, show a reservoir and dam just completed at Beetaloo, in South Australia, for the Government of that colony, by Mr. A. B. Moncrieff, C.E. It is intended to store water for irrigation purposes.

It was in May, 1885, that the survey for this scheme was begun, and during the same year an act was passed authorizing the construction of the dam. In the following December the first of the temporary head works and pipe-laying began. The temporary reservoir was used to supply places within reasonable distance of Beetaloo, but the completed scheme will serve an area covering 1,715 square miles. The importance of the reservoir will be understood when it is observed that not only are the interests of the farmers to be served, but that the townships of Moonta, Kadina, Wallaroo, Tickera, Alford, Port Broughton, Gladstone, Port Pirie, and other places will be supplied from Beetaloo. Up to the present time 255 miles of main pipes have been laid, the sizes varying from 18 in. to 2 in. in diameter. The pipes were all locally manufactured, and the Engineer-in-Chief speaks of them as highly creditable samples.



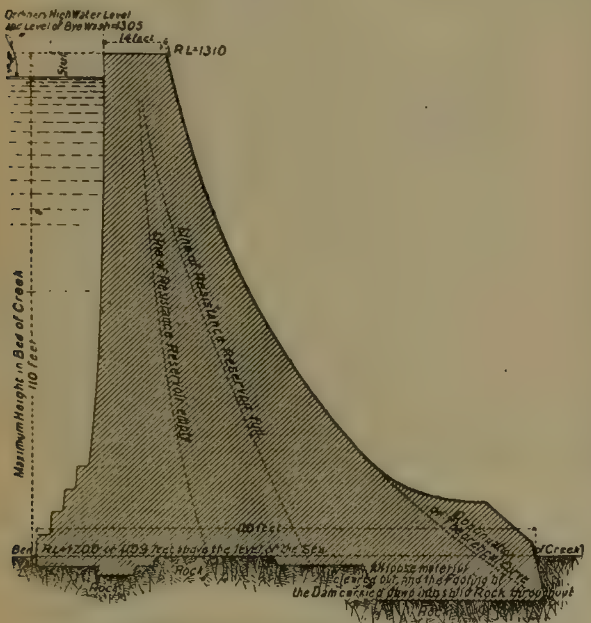

THE BEETALOO DAM, SOUTH AUSTRALIA.

The main interest centers in the concrete dam, which ranks as one of the largest dams in the world, and is certainly the largest concrete dam in the Southern Hemisphere. This work was started by Mr. Mestayer, the late hydraulic engineer, in 1888, and Mr. Jobson has been the Resident Engineer. In May of the same year the present Engineer-in-Chief, Mr. A. B. Moncrieff, took the work in hand, and as soon as the diagrams and stresses were checked by him the placing of the concrete was proceeded with. This continued with few intermissions until last October, so that the laying of the concrete occupied two years and six months.

About 60,000 cubic yards of cement concrete were required. The height of the weir is 110 ft., and the width on the top is 14 ft. The length is 580 ft., and the cross-section is in accordance with Professor Rankine's formula, the horizontal curvature having a radius of 1,414 ft. The stone and sand required were obtained in the neighbor-

hood, but the cement had to be imported from Europe. Machinery was employed to mix and deposit the whole of the concrete. To the western side of the dam there is a bywash, with massive training walls, which are partly excavated in the rock on the hillside. When the reservoir is full and the water flows over this bywash, there will be a pretty cascade down the hillside.

At present the reservoir is only half full, but the supply is constantly being augmented by the springs, which are running strongly. When full, the lake will be 105 ft. deep at the dam, about a mile and a quarter long, and on the average eight chains wide. In places the width is much greater, as there are several long reaches, but the average



CROSS SECTION OF DAM

THE BEETALOO DAM.

width is only eight chains. The capacity of the reservoir is 800,000,000 gallons, and on the whole of the works, up to date, there has been expended about $2,410,000, of which amount $570,000 was spent in the construction of the dam.

## THOUGHTS ON MARINE ENGINEERING.

By Aloha Vivarttas.

Probably there is no trade more conservative and "set in its ways" than the old line of shipbuilding, which, from the small beginning of building vessels whose greatest dimensions did not exceed the length of a single stick of timber, has grown in the size of its product, the ships, without any corresponding growth in the size of its material, the timbers.

Hence, from the increase in the number of joinings necessary to gain the increase of size, the big ship of to-day bears no comparison with the small one of yesterday in the all-important point of strength; for it appears that the builder of wooden ships never recollects that a given ratio of increase in the linear dimensions of a vessel calls for an increase of strength equal to the cube of such ratio in the construction of the larger vessel.

Take, for example, two vessels of the same model, but one of them one-fourth longer, wider and deeper than the other, and the former needs twice the strength of the latter in all its parts; or if one be double the length, breadth and depth of the other, she will need eight times the other's strength, since she will carry eight times the other's load over the same hills and gullies, and must bear eight times the strain at every point.

Again, if one be double the length, but the same breadth and depth as the other, she needs four times the other's strength longitudinally, for she has double the weight and length on the same depth.

Only a few days ago we were called upon to admire one of the biggest wooden ships afloat—just built and, as usual, changing her shape visibly according to her weight and bearing—a ship differing in no essential from many another of ancient build, except in an increase of size and proportionate decrease of strength.

The builder of iron ships took his methods of construction, with his model or external form, from the wooden ship; and although less limited by his material, as in the size of trees, he is yet far from seeing his way to build large and, at the same time, strong vessels, or to make them handy.

It is supremely ridiculous to see an iron ship with an iron mast extending clear down to her keelson, like her wooden prototype—a method of construction, costly and useless in wood, copied by imitators, not engineers.

So also in steering, the idea of causing a ship's head to turn to the right by pushing her stern to the left, which was not without its disadvantages in a small boat, is, in large vessels, absurd.

Imagine an old farmer so stupid as to hitch his reins to his horse's crupper to steer him; if he used power enough it might work, causing collisions on the road, very much as it does in ships. The engineer will yet learn to divide the rudder, and put one half of it in the stem, one-half of it in the stern, and, by using both at once, turn the big ship in a curve of one-half the radius now required.

It is said that it is easier to divide the water laterally than to compress it vertically at any one depth. So also it is easier to divide the water laterally at the surface than to divide it laterally at some distance below, and this difference increases with the depth of the vessel.

So also if a ship of a given size and model requires a certain amount of power for a given velocity, a ship of the same model and double her displacement would take more than double the power at the same velocity, or, if of double displacement, should have a greater proportion of breadth to depth, to enable her to make the same speed with double the power.

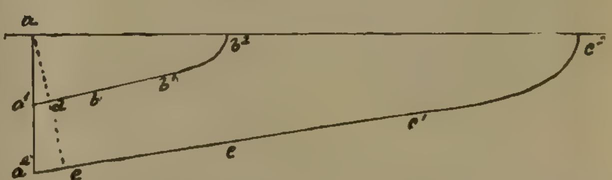
The resistance to lateral movement in the water at any one depth increases with the distance only, while the resistance to lateral movement at different depths increases with the depth also; so that while a ship of the same depth and twice the breadth of another might require twice the power at any given speed, a ship of twice the depth and the same breadth as another will require from 20 per cent. upward more than double the power to attain the same speed.

Hence the more a ship weighs the less water she should draw in proportion to her weight. Thus the diagram, fig. 1, shows two body sections, the depth of one being 5 ft. and of the other 10 ft.

It is manifest that water located on the line $a$, $a^1$, $a^2$ must, as either vessel passes it, move out to pass the surfaces $b$, $b^1$, $b^2$ and $c$, $c^1$, $c^2$ respectively.

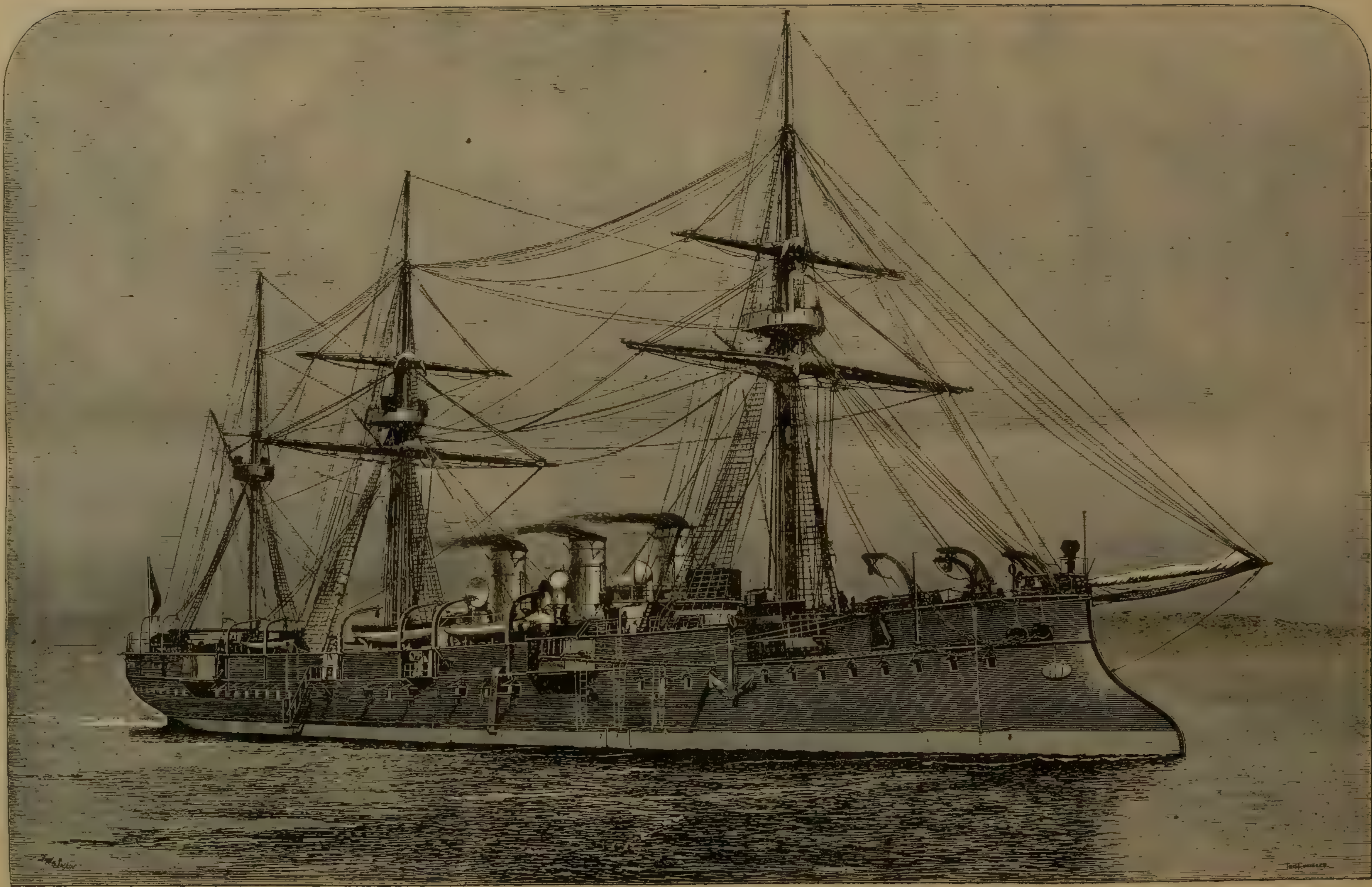
These lines show the natural proportion when the water which passes either of the points $b$ or $b^1$ shall offer the same resistance to the motion of the vessel as the water which passes the point $b^2$ does; and when the water which

Fig 1



passes either of the points $c$ or $c^1$ shall give the same resistance to the progress of the vessel as that which passes the point $c^2$ does. Observe that while the depths bear the proportion, the one to the other, of two to one, the beam $c^2$ is more than double the beam $b^2$; and by so much is it harder to move the water from $a$ or $a^2$ to $e$, than from $a$ or $a^1$ to $d$. This is in open ocean; the difference shown increases rapidly as the ship gets into shoal water.

A proper deference to this law also favors a ship in the matter of stability and convenience in handling, and is of



THE NEW FIRST-CLASS CRUISER "LE TAGE," FOR THE FRENCH NAVY.

especially great advantage when on soundings, where quick and accurate steering are called for. Had the builders of wooden ships followed up this matter and consulted the experience of their navigators, the big ships of to-day would not be simply overgrown brigs of a hundred years ago, nor the steamers of much the same proportion, and about as seaworthy as canal-boats.

The various problems involved in marine work, handled *de novo* by the class of men which has handled the bridge business in the United States during the last 50 years, would put the seagoing machine as far from the present favorites as a good pinned truss or cantilever bridge from the narrow span stone arch of former days. And even as the stone arch is, for small culverts which are not liable to freshets, very near perfection to-day, so the wooden style of boat building is, for yawls and cat-boats, very satisfactory.

It may be noted that the rules of the Underwriters do passably well for small vessels, but are less and less trustworthy as the size gets beyond that common for the time such rules have been in vogue. The man who designs for new purposes or larger sizes gets little assistance from them.

It may be questioned if the marine world, in its engineering and governing details (which are inseparable), will bear the hand of the landlubber. And no doubt the conservative element of the old "gentlemen rope-haulers" will growl, as it does to-day, at every proposed change. But looking back over the years past, which are still in sight, it is seen that all of the real marked progress in these matters is the work of men who were not trained to the sea.

Thus, without going into the controversy about who first conceived or suggested an idea, it is evident that the application of steam, the evolution of the Mississippi and the North River styles of steamboats, the New York ferry-boat (sometime driven by horses), and the fore-and-aft schooner were never brought about by the *deep sea* men.

Compare these instances of American work with the straight-bodied, double-truck car and pinned truss bridge of the same class of men, and note the same handwriting in each. Even in maritime law, R. H. Dana, not trained to the sea in the regular way, but taking a dose of it for his health only, by his "Handbook of Marine Law," which circulated in the forecastle 40 odd years ago, probably did more in the interest of law and order than all of the courts from that time to this.

The fore-and-aft schooner is more of an advance upon the old style of square-rigged vessels than the old sailormen really like to acknowledge. They can seldom handle one properly, the old rules not being all applicable, and few of them will believe that vessels so proportioned and rigged can safely go to sea when light without ballast. Yet such is a common custom of large schooners on the American coast.

The old-time mariner, handling a good sea boat, felt safe on deep water far from land, or in a landlocked harbor secure from sea. To anchor off the coast was to him a *dernier ressort*, after hope was gone. But since the blockading fleet, comprising ships, barks, schooners, steamers, and even ferry-boats, rode out the war of 1861–65, anywhere from Cape Hatteras to the Rio Grande, boldly hanging to their anchors in any weather, the coaster has taken heart of grace, and if the wind baffles him lets go his mud-hook with confidence in his ground-tackle, anywhere along the beach.

The sea calls for men who know metals, as the old ship carpenter knew wood; who know the steam-engine and all of its connections as the old boatswain knew his sails and rigging; and who can handle electricity as the old quartermaster could trim a binnacle lamp. And the master at sea must know them all, both new and old; for as the railroad has not exterminated the horse, so steam has not done away with canvas; and as the railroad engineer may easily know how to handle a "fast trotter," so the steam seaman may easily keep the run of canvas work. The engineer, in the broadest sense of the word, will find ample room at sea,

(TO BE CONCLUDED.)

## A NEW FRENCH CRUISER.

THE accompanying illustration, which is taken from the London *Engineer*, shows the French cruiser *Le Tage*, which is one of the finest new vessels in the French Navy. This ship is a first-class protected cruiser having twin screws. She is 389 ft. 9 in. in length between perpendiculars; 53 ft. 6 in. beam at the water-line; 35 ft. 11 in. deep; has a mean draft of 22 ft. 10 in., and a displacement of 7,045 tons.

The hull is built of steel, but the stern-post, keel and the plating of the protective deck are of iron. This deck covers the engines, boilers and magazines, which are also protected by numerous water-tight bulkheads and by the belt of cellulose.

The contract speed of this ship was 19 knots under forced draft, and this she maintained at the trial. Her highest speed with natural draft is about 16 knots. The coal capacity is 900 tons, when the bunkers are all filled. The ship carries three masts and can make a considerable spread of canvas.

This vessel was built under contract by the Société des Ateliers de la Loire, the contract price being $1,750,000.

The armament consists of six 16-cm. (6.3-in.) breech-loading rifle guns on the upper deck; ten 14-cm. (5.5-in.) guns in the battery; three 47-mm. (1.85-in.) rapid-fire guns, and twelve 37-mm. (1.46-in.) Hotchkiss guns. There are also seven torpedo-tubes placed above the water-line.

The engines are of the triple-expansion type and are horizontal. The cylinders are 43 in., 68 in. and 100 in. in diameter and 47¼ in. stroke. The low-pressure cylinders lie forward, and the crank shafts are fitted with coupling-boxes, so that when low powers suffice the low-pressure cylinders are put out of use, and the engines then work compound and develop 1,970 H.P., making 52 revolutions per minute. With natural draft and all the cylinders in use the power is 8,950, the revolutions being 89 per minute; and with forced draft the power is 11,370, and the revolutions 97 per minute. The safety valves are loaded to 150 lbs. The valve gear is Joy's. Steam is supplied by 12 boilers, arranged in groups of four in water-tight compartments. The shells are 14 ft. 3 in. in diameter and 10 ft. 9½ in. long. There are in each boiler three Fox furnaces, 3 ft. 7 in. in diameter. The grates are 7 ft. 7 in. long. The total grate surface is 930 sq. ft. The tubes are of brass, with the exception of the stay-tubes, which are of iron. The diameter inside of the brass tubes is 3 in., that of the iron tubes 2⅝ in. There are three chimneys, one to each group of boilers. They are 8 ft. 3 in. in diameter.

There is one surface condenser in each engine-room. Each contains 5,633 tubes, 0.7 in. diameter and 9 ft. 8 in. long. The total surface is 10,097 sq. ft., or about 1.75 sq. ft. per H.P. with forced draft, 2 sq. ft. with natural draft, and 8 sq. ft. when working compound.

The pumps are worked by distinct inverted cylinder engines. There are two air pumps in each engine-room 28¾ in. diameter and 19⅝ in. stroke. They are single-acting, and make 81, 138, and 150 double strokes per minute, according as the engines are working compound, with natural, and with forced draft. There is one centrifugal circulating pump in each engine-room, making 100, 147 and 160 revolutions per minute. The disk is 48 in. diameter. There are two feed-pumps, single-acting, in each engine-room, 6⅞ in. diameter and 19 in. stroke. The main crank shafts are hollow, and 15¾ in. diameter, the hole being 7 in. in diameter. The connecting-rods are four cranks long. The piston-rods are 6⅝ in. diameter. The cylinders are jacketed all over the high-pressure and intermediate cylinders. The forced draft fans deliver into closed stokeholds. They are driven by compound engines, and each can deliver about 70,000 cubic yards of air per hour, at a pressure of 1 in. to 1½ in. water. There are four of these blowing fans. The screws are four-bladed, of manganese bronze.

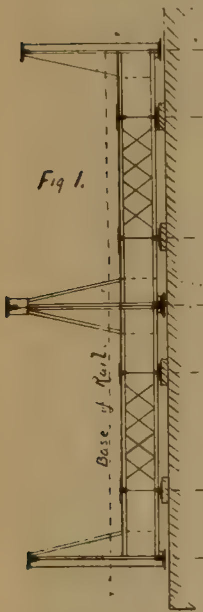
The main-bearing brasses are composed of an alloy of 84 copper, 16 tin, and 2 zinc. The bearings in the screw alleys are of copper 86, tin 14, zinc 2. Stuffing-box glands, etc., are of copper 88, tin 12, zinc 2. The boiler

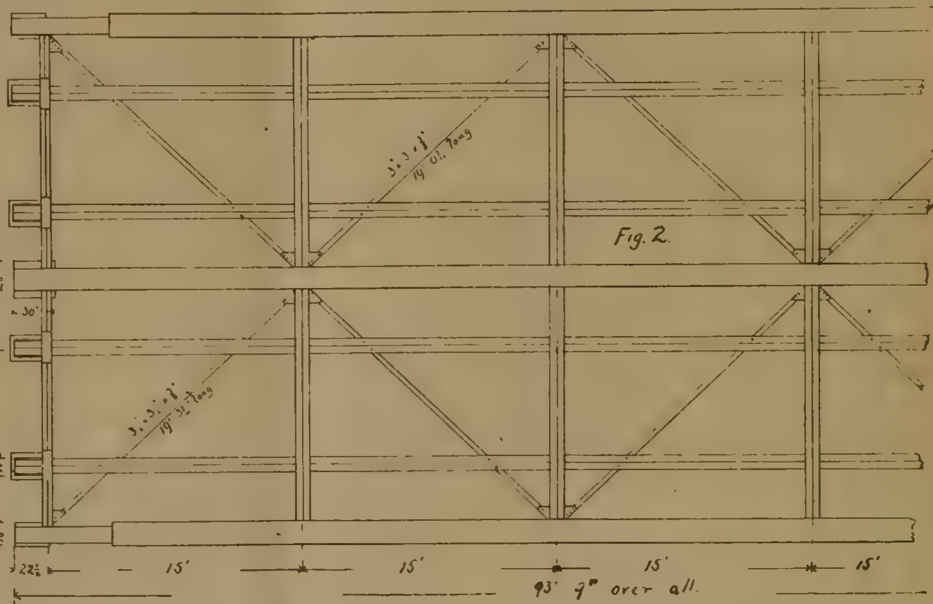
fittings are of copper 90, tin 10, zinc 2. Brass tubing, so called, when used, is of copper 94, tin 6, zinc 2. The anti-friction metal is copper 4, tin 96, antimony 8.

The valve gear is so arranged that the cut-off in the high-pressure cylinder is variable between 25 and 74 per cent., intermediate cylinder between 25 and 70 per cent., and in the low-pressure between 37 and 79 per cent.

## A NEW PLATE GIRDER BRIDGE.

THE drawings given herewith show a double-track plate-girder bridge recently built by the Passaic Rolling Mill Company, of Paterson, N. J., for the Delaware, Lackawanna & Western Railroad. In these figs. 1 and 2 are



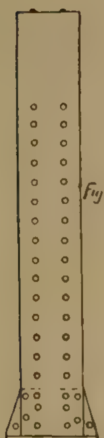





Fig. 3

Fig. 7.

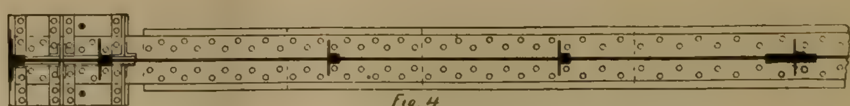


Fig. 4.

WHITE'S BRIDGE, DELAWARE, LACKAWANNA & WESTERN RAILROAD.

The ship is lighted by electricity. There are two Mangin projectors 2 ft. in diameter, and there are 300 incandescent lights in each compartment. Current is supplied by three large Gramme dynamos arranged in the engine-rooms.

Compressed air is supplied for the torpedoes by Brotherhood machines.

respectively an end elevation and a half plan of the bridge, showing the general arrangement. Figs. 3, 4, 5, 6 and 7 show the center girder; fig. 8 an end panel, and fig. 9 one of the beams which carry the floor.

The bridge is 93 ft. 6 in. span and has three girders; it is built entirely of steel. The center girder weighs 35 tons and the two outside girders 23 tons each. The

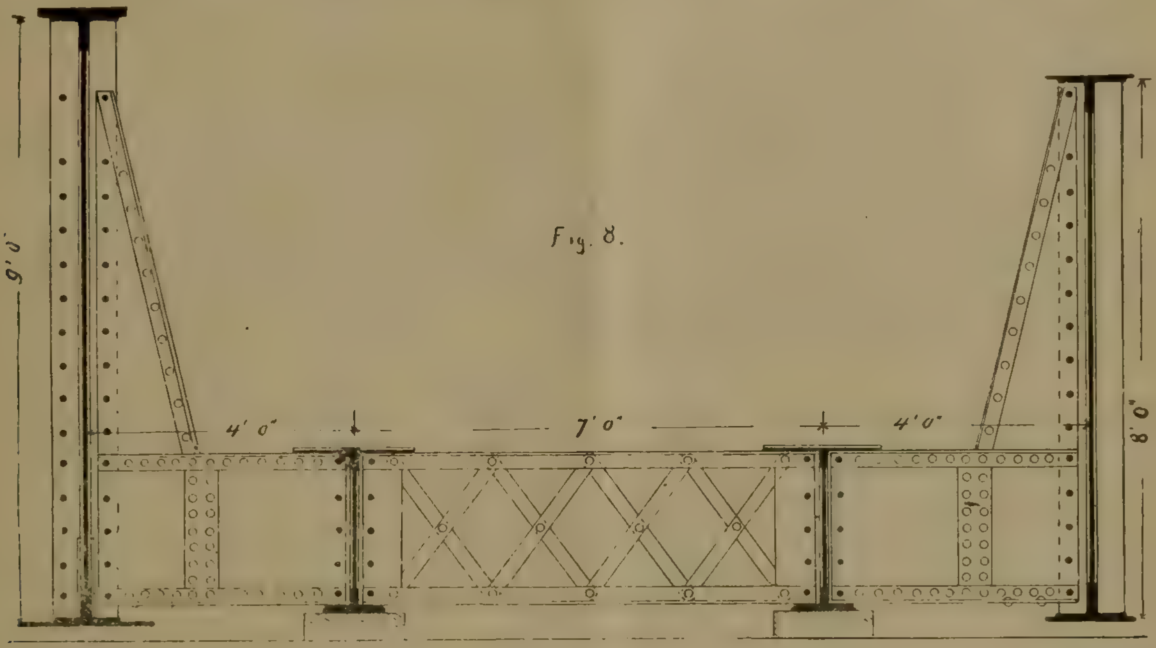
structure is proportioned for a moving load consisting of two 101-ton consolidation locomotives.

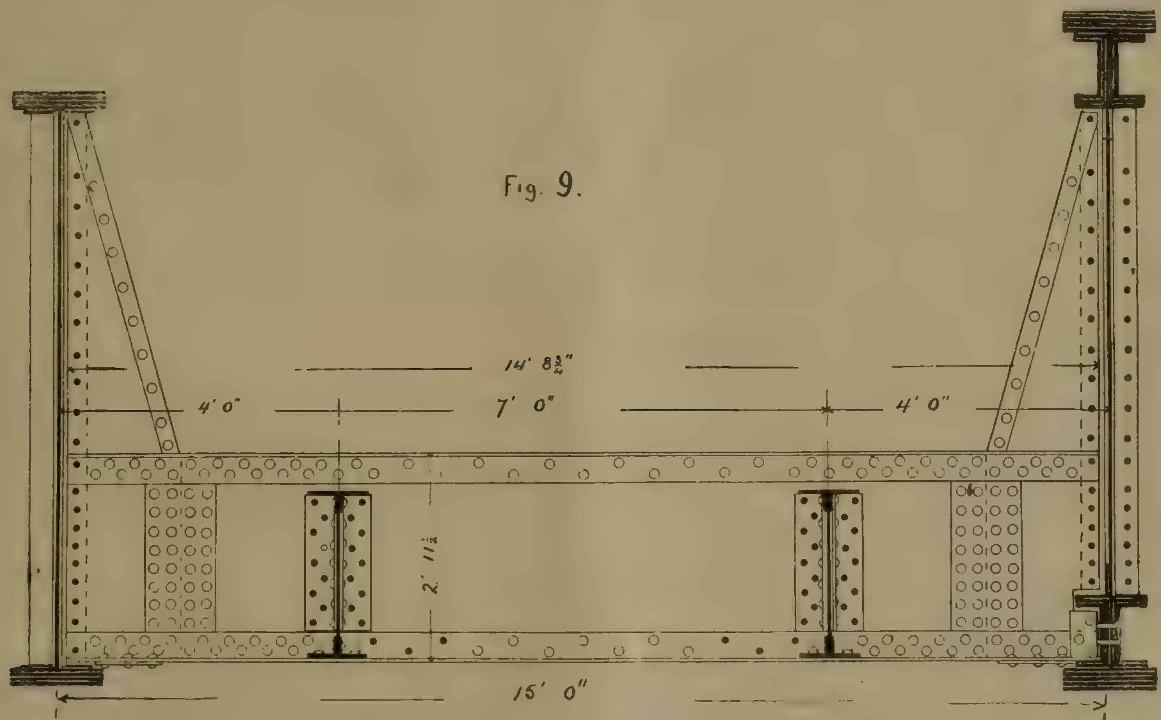
The illustrations show the construction of the bridge so well that but little further description is necessary. From figs. 1 and 2 it will be seen that the main girders are spaced 15 ft. apart. The floor-beams carried on the girders are also spaced 15 ft. apart; the diagonal bracing is of 3 × 3 × ⅜ angle-iron, except in the end panels, where it is 3½ × 3½ × ⅜ in.

The center girder is 9 ft. in depth, the web being of $\frac{7}{16}$-in. steel plate; the general construction and bracing are shown in the drawings. The side girders are 8 ft. in depth, the web being of ⅜-in. plate. The floor beams are 35 in. in depth and their construction, bracing and connections with the main girders are shown in fig. 9. The end studs differ somewhat in construction, as shown in fig. 8.

The stringers are spaced 7 ft. apart between centers and are 28 in. deep, having a web plate ⅜-in. thick. Their construction presents no special peculiarities. In the work generally ⅞-in. rivets are used.

The bridge is a good example of recent construction in the plate-girder type, which is now generally adopted in good practice for spans up to 100 ft., few trusses of less than that length being found of recent date.




WHITE'S BRIDGE, DELAWARE, LACKAWANNA & WESTERN RAILROAD.

BUILT BY THE PASSAIC ROLLING MILL COMPANY, PATERSON, N. J.

## THE GREAT SIBERIAN RAILROAD.

THE preliminary work on the Siberian Railroad is being pushed forward. The engineer corps are in the field on the extension of the Samara-Oufa-Zlatooust line eastward, and are also completing the arrangements for beginning work on the Western Siberian section from Tomsk to Chelabinsk. A careful examination is being made of the river crossings on this section. Work upon it will probably be begun first from the western end.

As already noted, work has been formally begun on the Pacific end of the line, known as the South Oussouri Section, which will extend from the port of Vladivostok to Grafskaia on the Oussouri River, forming a rail out'et for the extensive system of navigation formed by the Amoor River and its tributaries. The work on this line was opened by the Czarovitch, who is now inspecting the proposed line of the road.

We give below, as showing the interest taken in this line by the Government, the imperial rescript addressed to the Czarovitch. This was dated at St. Petersburg, March 17, and was made public on the occasion of the formal opening of the work at Vladivostok on May 11–23 last:

> Having now ordered the beginning of the construction of a continuous Trans-Siberian Railroad, in order to connect the rich and fertile Siberian country with the net-work of Russian railroads, I charge you to announce this my decree when you again reach Russian soil, after finishing your tour through Eastern countries. I charge you to put in place at Vladivostok the first stone of the Oussouri Section of the Great Siberian Railroad, which, it has been decided, is to be built by the Government and at its expense. Your eminent co-operation in the beginning of this truly national work is to be an evidence of my wish to facilitate the connection of Siberia with the other parts of the Empire, and to show to this country, so near to my heart, my care for its peaceful progress.
>
> Invoking the benediction of the Almighty on your long journey through Russia, I remain, loving you,
>
> ALEXANDER.

There is now no doubt of the active continuance of work on this line, and the Russian iron and steel works are already turning out material for its use.

## RAILROAD TUNNELS IN WISCONSIN.

(Abstract of paper by Mr. Woodman; read before joint meeting of Engineers' Clubs of Minneapolis and St. Paul, May 8th.)

IN this interesting paper the writer showed that the topographical slope of Wisconsin is from the northeast to the southwest, so that the Wisconsin River has a fall of 900 ft. in its course to the Mississippi.

The two large valleys of the Wisconsin and Rock Rivers are followed, the one by the Chicago, Milwaukee & St. Paul, the other by the Chicago & Northwestern Railroad. The elevation of the Rock River valley is about 780 ft., and that of the Milwaukee Road is about 600 ft.

Although the topographical features hardly indicate it, there is one point, included within a radius of 10 miles, where the headwaters of several rivers are found, where six tunnels are located, having a total length of two miles and built at a cost of $700,000.

The ridge elevation at this point is about 1,300 ft. and the contours quite broken.

The tunnels are all in the same geological formation, the St. Peter sand rock, which underlies the Trenton lime rock. There is the same formation in the locality of St. Paul.

This sand rock generally consists of fine, pure sand, possessing very little cohesion, and is therefore very easily worked.

A peculiar geological feature of Wisconsin is the fact that, following the country down from northwest to southeast, the different formations from the earliest to the present one are in view.

Of 26 miles of road included within the above-mentioned circle, 21 miles are on a 66-ft. grade, which is almost a mountain grade. The difficulty of operating is apparent from the fact that a mogul engine with 18 × 24-in. cylinders can haul only 12 cars.

The Greenfield Tunnel, used by the Chicago, Milwaukee & St. Paul, is one-quarter mile long in a very soft portion of the rock. The tunnel had to be timbered, and finally it became so unsafe that a new one had to be built, 45 ft. from and parallel with the original one. The grade in the new tunnel is only 35 ft. per mile, which is the maximum grade of this road. Working one end at a time the average progress was 8.3 ft. for 24 hours.

The Northwestern has three tunnels, all running on township lines about 6 or 7 miles apart. The longest, 3,810 ft., was built under Mr. Woodman's supervision.

The west approach was very much broken up. Both ends were worked and two shafts, one vertical 75 ft. deep, and one on a slope 135 ft. long. Considerable trouble was caused by water. The tunnel passed through a regular artesian well. Two shifts were worked, each of 11 hours. The average progress in the three tunnels was: No. 1, 53.7 ft. per week; No. 2, 52.0 ft.; No. 3, 21.7 ft. A bonus was offered in No. 3 to pay the miners $5 for every foot made over 33 ft. per week, and the progress was thus advanced to 42 ft. as against 21.7. The greatest progress in No. 3 was 51 ft. per week in a soft place.

Generally the heading was squared in three rounds; first three foot-holes were excavated, then three mean holes, and finally three top holes. The area of a section was about 12 square yards. Only hand drills were used. The drillers could be heard 270 ft. distant. The average taken out in No. 1 was 12.98 yds. per foot; No. 2, 12.64; No. 3, 11.2. No. 3 was estimated at 11.1 yds. per foot, but all three were designed to be of the same dimensions.

The contract price in No. 1 and No. 3 was $4.50 per yard; in No. 2 it was $3.75. There was no particular reason for these prices, except the guesswork of the contractors. No. 3 cost every cent that was paid for it. In 1872 the contractor wanted to quit, but the company guaranteed to pay him $10 per yard for the remaining 10,000 yds., and yet he had no profits. The actual average cost was $5.79 per yard, and at the time the average cost of hard rock tunnels was $5.89. At that time out of 300 tunnels in existence, only 12 were longer than No. 3.

The following gives the comparative length and cost of some of the tunnels:

| | Length. | Cost per foot. | Total cost. |
|---|---|---|---|
| The West Wisconsin Tunnel........ | 882 ft. | $43.01 | $37,913 |
| New Greenfield Tunnel......... ... | 1,230 " | 60.54 | 80,518 |
| No. 1 Northwestern R. R. Tunnel.. | 1,694 " | 58.44 | 98,971 |
| No. 2 " " " .. | 1,594 " | 47.40 | 75,557 |
| No. 3 " " " .. | 3,810 " | 64.90 | 247,272 |

A flat car with frame on was run through to test dimensions. The average dimensions were 16 × 19 ft. clear.

The shafts were filled up after the tunnels were finished.

No. 2 was lined while in operation. Iron centers were used made of rails on 3 ft. centers, using 16 ft. lagging. Four brick rings were put in. Three differently rigged flat cars were used to do the lining, one for the footing and lower wall, one for the intermediate portion, and one for the top.

## THE UNITED STATES NAVY.

BIDS for the new fast cruiser, No. 13, were opened at the Navy Department in Washington, June 1. This cruiser, with a few slight alterations, is the same as No. 12, which is now under construction at the Cramp yards in Philadelphia. She will have three screws, and is intended to make a higher speed than any vessel yet built for the Navy. This ship has already been fully described in our columns.

Three bids were received: from the Union Iron Works, San Francisco, $2,793,000; William Cramp & Sons, Philadelphia, $2,745,000; Bath Iron Works, Bath, Me., $2,690,000. The contract will probably be awarded to the Bath Company. This is the largest vessel it has yet undertaken; it is now building two of the 1,000-ton cruisers and the Ammen ram. The plant has been

steadily increased, and it is understood that the works are in good condition to undertake this large ship. The engines will be built by the Quintard Iron Works, New York.

The general dimensions of this ship are: Length, 400 ft.; breadth, 60 ft.; depth, 30 ft.; displacement, 7,300 tons. She is expected to make a sea speed of 21 knots and a maximum speed of 22 knots an hour.

### TRIAL OF THE "NEWARK."

The new cruiser *Newark* was given a trial to determine her qualities as a sea-boat early in the month. The ship started out from Hampton Roads and made a trip lasting three days, part of the time in very heavy weather. Trials were made as to speed, turning and manœuvring powers, and in the use of guns at sea. The ship behaved well in all these trials, some of which were made in a northeast gale with a very heavy sea. Some slight changes in deck features and minor points are to be made, and the ship will then probably be put into commission, and attached for the present to the Squadron of Evolution.

### TRIAL OF THE "VESUVIUS."

The official report of the Board on the late trial of the *Vesuvius* has been made. The essential part of the report, after giving the preparations for the trial, is as follows:

Six shots were fired with the starboard and five with the middle gun, May 18. As the valve of the port gun was out of order, no projectiles were fired from it. From the six shots fired with the starboard gun a range curve showing the valve openings necessary for all ranges to more than 2,200 yards was constructed; but a similar curve could not be made for the middle gun. On May 19, six shots with the starboard gun were fired for accuracy. The valve openings for this firing were taken from the range curve, and corroborated it very closely. Three of these were fired with the vessel stationary and opposite buoy 1, and the other three with the vessel steaming at about 12 knots, and while opposite buoy 1. Also on the 19th three more shots were fired from the middle gun, using the data of the previous day for regulating the valve openings. The results of this firing and of that previously mentioned from this gun were very irregular and not of such a nature as to enable us to draw a fair range curve.

On May 20 the firing was resumed. Three shots fired at the word of command, the distance being estimated by a member of the Board at one mile, ¾ mile and ½ mile. The results of this firing were good; the shots fell at the distances stated from the buoys aimed at,

No. 1. Line, 43 yards beyond.
No. 2. 8 yds. rt., 104 yds. beyond.
No. 3. 24 yds. rt., 24 yds. short.

On the occasion of this firing the sea and wind were moderate, and the motion of the vessel, though not excessive, was not entirely conducive to good firing. After this firing was over, the *Cushing* towed the old cutter procured at the Navy Yard across the line of fire at a speed of 10 knots. The *Vesuvius* was at this time proceeding at a speed of 17 knots, and her rolling and pitching motion greater than in the firing just executed. The gun was fired at the word of command, and at distances estimated by the Board. These three shots fell as follows:

No. 1. 20 yds. left, 16 yds. short.
No. 2. 0 left, 300 yds. beyond.
No. 3. 8 yds. left, 275 yds. short.

These shots were fired at one mile, ¾ and ½ mile respectively.

In conclusion the Board would state as follows: The accuracy of fire of the starboard gun, under the conditions, we consider good; that of the middle and port guns we are unable to criticise, because the valves were not in satisfactory working order. The valve of the starboard gun has been modified by Lieutenant Seaton Schroeder, and worked satisfactorily throughout.

The range can be very readily altered; the setting of the valves can be changed to any point from extreme to shortest range in five seconds.

The effect of a moderate sea and wind on the general efficiency of the guns and their range is very slight.

Generally speaking, the vessel as a gun platform behaved very satisfactorily. There are many details concerning the steering-gear and conning-tower which could be very much improved.

As to the actual efficiency of the vessel for offensive purposes, the Board has little data on which to base an opinion.

On May 20 three shots were fired at a target towed by the *Cushing* at a speed of 10 knots across the line of fire, the *Vesuvius* steaming 17 knots; one of these would undoubtedly have struck a vessel. This the Board considered a favorable showing under the circumstances.

The Board considers that the fittings and appliances for loading and firing these guns, as fitted, are very crude, and capable of great improvement.

The Board would recommend that the guns should be carefully ranged in some suitable locality where the fall of the projectiles can be accurately determined from shore stations; that some simple and suitable sight should be fitted, and such changes made in the mechanism for loading and firing the guns as may be found advisable, and that the vessel be then subjected to such further tests as will fully determine her efficiency as a torpedo thrower.

## RECENT EXPERIMENTS WITH ARMOR-PLATES.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

THE armor-plate trials held at Annapolis, in September of last year, awakened throughout the United States a profound interest, which was by no means confined to military and naval circles. Not only were these tests the most important ever had on this side of the Atlantic, but the first conducted here under the modern conditions of attack and defense. One might go further and add that the results obtained were so unlooked for that the interest awakened was co-extensive with the whole armor-making and armor-using world. But pronounced as these results were, it would not be safe to accept the conclusions of enthusiastic newspaper writers that the whole question of armor-plate had been settled for good and all, and that the great compound-armor-clad fleet of Great Britain had, so to speak, been knocked out in a single round.

The struggle not only between the gun and the armor-plate, but between compound and all-steel armor has been, up to a very recent date, so fairly equal that a little caution is necessary in making predictions for the future. As the matter now stands the gun is unquestionably in the lead—that is, the best guns, under favorable conditions of range and target, can perforate any armor-plate of practicable thickness that can be carried by a ship of war. As to the armor-plate, all the more recent trials indicate a decided superiority of steel over compound armor. It is proposed to notice briefly the more important of these experiments.

It will be remembered that the first steel armor-plate aimed to oppose to a projectile a uniform resistance throughout its whole thickness, while the compound plate, then and now, offers to it the hardest possible steel face attached to a backing of soft wrought-iron. Theoretically, at least, the compound plate should be the most effective, since, while it opposes to the energy of the shot a sufficient hardness of face to make that energy act destructively against itself, its soft, tenacious back neutralizes the inclination of all hard plates to crack through and through and thus go to pieces. Practically, however, the compound plate has two serious drawbacks. The hard outer face is very prone to separate and fall away from its backing under the shock of striking projectiles, on the one hand, while upon the other the entire work of resistance is thrown upon the comparatively thin face—say less than half of the whole thickness of the plate. Once through this face and the soft iron back can bring but little additional aid in opposition to a carefully tempered steel projectile.

The two varieties of compound armor—the Cammell and the Brown, known also by the names of the inventors

as Wilson's and Ellis'—differ only in the methods of manufacture. In both a soft iron back is prepared and raised to a welding heat, and directly upon this, in the Cammell plate, is run the melted steel, which partially carbonizes a layer of the soft iron and creates a zone of semi-steel. In the improved Wilson process two layers of steel are run upon the soft back; one of very mild the other of very hard steel. In the Brown process the hard face-plate is prepared in advance, and then between this face and the iron back molten steel is introduced, forming a welding joint between the two. The plates, in both cases, are reheated and rolled down to the proper thickness. After being planed and machined to the proper form and dimensions, the faces of the plates are tempered and annealed to remove internal strains.

The difference in hardness between an all-steel and the face of an improved Wilson plate is indicated by the fact that while the former has only about 0.4 per cent. of carbon, the latter contains from 1.25 to 1.50 per cent.

It will be observed that nearly all the recent efforts to improve the quality of all-steel armor plate have been in the direction of securing this varying degree of hardness from front to back. In the Schneider plate the face is given a somewhat greater hardness by tempering in oil. By the Harvey process it is claimed that any mild steel plate can be so tempered as to give a great face-hardness, while the back retains its original quality, without creating any tendency to separation. Recent experiments indicate that this claim is well founded. In just what way an alloy of nickel improves an armor plate may be hard to explain. That it does improve it can hardly be questioned, giving it greater toughness and elasticity, if not greater hardness.

Wrought-iron armor held undisputed possession of the field until the Schneider all-steel armor was brought forward so successfully in the Spezzia experiments of 1876. A year later the compound plate, as at present manufactured, appeared, although Cammell & Company had entered the lists ten years earlier as manufacturers of a combination of iron and steel, but in these earlier methods attempts were made to weld the steel face directly to the iron back. The Schneider plate, in reaching its present state of excellence, has passed through many stages of hardness, from the steely iron of the first plates to those used in the Russian experiments of 1882, which were almost as brittle as cast-iron.

An extended series of trials were held at Portsmouth in 1888, in which steel and compound plates, all of English manufacture, were brought into competition. These trials clearly demonstrated the superiority of English compound over English all-steel armor plate. In the Helder (Holland) trials, November, 1889, four compound plates were tested—two English, a Brown and a Cammell (Wilson's), and two French, a St. Chammond and a Marrel, both made under the Wilson patent. The result showed that English were superior to French compound plates, and called attention anew to the excellency of English-made compound armor, without however, settling the question of superiority between it and the French all-steel plate.

The possession of a projectile, such as we now have in the Holtzer, that is practically indestructible, places the trial of armor-plate upon a much more satisfactory footing than it has ever been before. It is now possible by calculation to match gun against plate in such a way as to give to the projectile a striking energy barely sufficient to perforate the plate before it. Under such conditions to measure the relative resisting qualities of rival plates is not a difficult matter. For this reason the trials that have been held during the past 12 months are particularly valuable. There has been no great overmatching either on the side of the gun or of the armor-plate. A brief examination into the details of the Ochta and Annapolis trials of last autumn, and the more recent ones at the latter place, will give a fair idea of the present state of armor development. It should be said that, excepting the Annapolis trial, the official reports are not at hand. The details given are, however, believed to be correct.

SCHNEIDER. NICKEL. CAMMEL.

FIG. 1. VIEW OF ANNAPOLIS PLATES AFTER FOUR SHOTS EACH.

### THE ANNAPOLIS TRIAL.

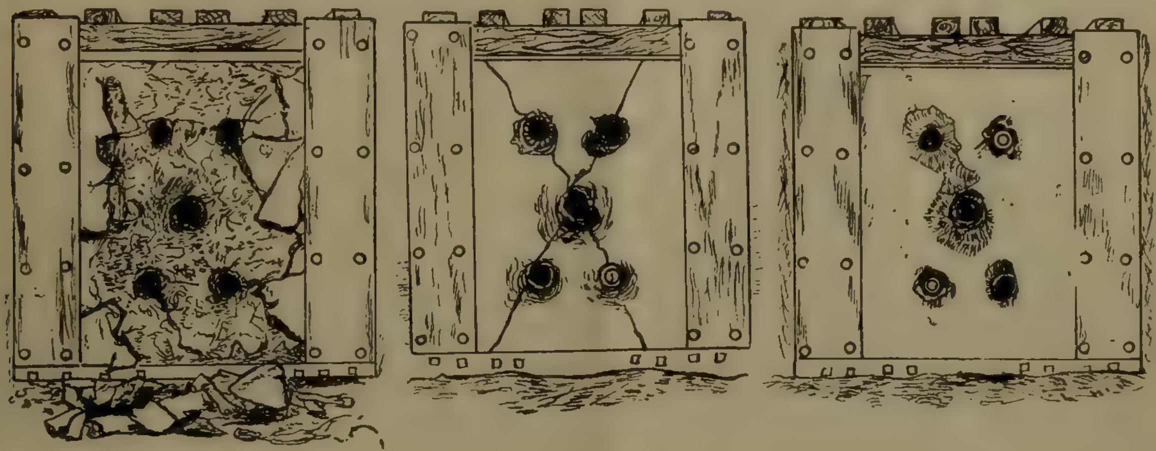
This trial, the most important ever had in this country, was originally intended as a test for Holtzer projectiles, and for this purpose the two French plates were purchased. Subsequently, at the request of Cammell & Company, it was made a competitive armor-plate test, and opened to all comers. The three plates entered were the two French steel and an English compound, Wilson's patent.

The Schneider plates were each 10.5 in. and the English

10.6 in. in thickness, and all 6 × 8 ft. The all-steel plates contained about 0.33 per cent. of carbon ; the nickel steel between 4 and 5 per cent. of nickel alloy. The backing was 36 in. of oak timber, well braced, behind which was a well-rammed mound of earth.

The gun was a 6 in. B. L. R., 35 calibers in length. The projectiles, Holtzer forged chrome-steel shell, weighted with sand and fragments of iron to 100 lbs. each. The charge in each case was 44½ lbs. brown prismatic powder ; the striking velocity of the projectile 2,075 foot-seconds, and the striking energy 2,988 foot-tons. The targets were arranged in a semi-circle, 28 ft. from the muzzle of the gun.

The trial began on September 18, when four shots were fired at each of the plates from the 6-in. gun, beginning in the lower right-hand and ending in the upper left-hand corner of the plates. Four days later a single shot from an 8-in. rifle was fired at the center of each plate. In the second trial a 210-lb. Firth armor-piercing shell was thrown by 85 lbs. of brown prismatic powder, with a striking velocity of 1,850 foot-seconds and a striking energy of 4,986 foot-tons.



CAMMEL. SCHNEIDER. NICKEL.

FIG. 2. FRONTS OF THE PLATES AFTER THE ANNAPOLIS TRIAL.

The accompanying figures will give a better idea of the appearance of the plates at the end of the trial than any written description can do. To summarize briefly, the effects of the shot and the behavior of the plates were as follows :

*Schneider All-Steel Plate.*—The first projectile penetrated about 10 in. and stuck, apparently uninjured. The penetration of the other three was about 12 in. in each case. All rebounded, two remaining intact except for a little shortening, the other breaking up into 5 or 6 pieces. The 8-in. shot penetrated about 15 in., rebounded and broke into three large pieces. About each shot-hole there was a front bulge of about 1 in. and a projecting fringe, and a back bulge about three times as great. The back bulge of the 8-in. shot was 6.25 in. At the end of the first day's trial, save for a few short surface cracks, the plate was apparently in good condition. The 8-in. shot started four through cracks, radiating from the center in the form of an X, as shown, but these were only through in places, and the plate still had strength to support its own weight.

The *Nickel Steel Plate.*—The first and fourth projectile fired on the first day broke up after penetrating 13.5 in. and 7 in. respectively ; the second and third stuck after penetrating 15.5 in. and 12.5 in. respectively. The front bulge averaged a little more than an inch ; the back bulge was from 4 to 6 in. The 8-in. shot formed a 3.5 in. crater in back of plate. There were no visible cracks on the plate.

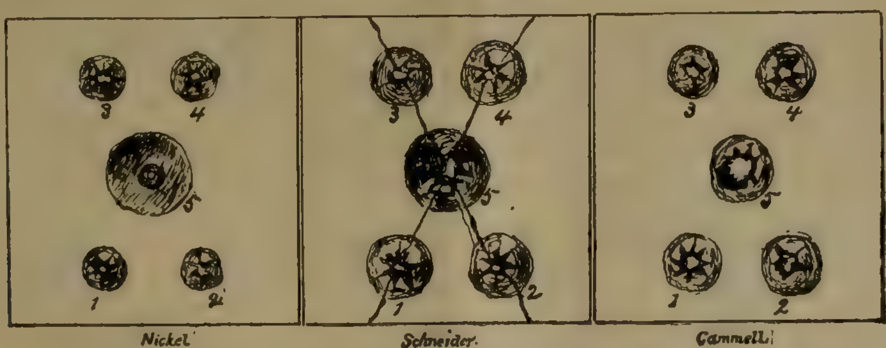



FIG. 3. BACKS OF PLATES AFTER THE ANNAPOLIS TRIAL.

The *Compound Plate.*—The first three projectiles, on the first day's trial, perforated the plate and lodged in the oak backing. The fourth passed through both plate and backing and broke up. The 8-in. shot tore a hole through plate, backing, and penetrated 15 ft. into the earth behind. At the end of the first day's firing the steel face above the upper shot holes had been thrown off, the face was badly cracked elsewhere, and the whole plate on the verge of disintegration. The 8-in. shot wrecked the plate, leaving but a few fragments of the steel face in place ; the front scaling off to a maximum depth of about 6 in. The following is the summary of the report of the Board :

The *Compound Plate* was perforated by all projectiles, and its steel face was destroyed. Two of the shells passed completely through both plate and backing.

Both *Steel Plates* kept out all projectiles, the All-Steel Plate showing slightly greater resistance than the Nickel Steel Plate, but the former was badly cracked by the 8-in. shell, while the latter remained uncracked. The Board, therefore, places the three plates tested in the following order of relative merit :

1. Nickel Steel ; 2. All Steel ; 3. Compound.

In the figures referred to fig. 1 represents the plates

after the four shots, at the end of the first day's trial; fig. 2 shows the appearance of the fronts of the plates after the 8-in. shot had been delivered; fig. 3 the backs of the plates after they were removed from their backing at the end of the trial; fig. 4 is from a photograph of the six recovered 6-in. projectiles.

I am indebted to the courtesy of the United States Naval Institute for the use of the plates of figs. 1 and 4.


FIG. 4. RECOVERED SIX-INCH PROJECTILES, "ANNAPOLIS" TRIAL.

*(Figures refer to Serial Number of Rounds.)*

### THE OCHTA TRIAL.

This took place at the Polygon of Ochta, near St. Petersburg, on November 11 last, under the direction of Russian naval officers. It is particularly interesting in that the conditions of the trial were very similar to those at Annapolis, while the results obtained were of a widely different character.

The gun was a 35-caliber, 6-in. B. L. R., of Russian make; the projectiles were likewise of domestic manufacture, but made upon Holtzer's system and under the direction of his own men. They weighed about 90 lbs. each, were 16 in. in length, and had a calculated penetration of 10 in. of steel or steel-faced armor. The average striking velocity of the five projectiles fired was a little over 2,000 foot-seconds and the striking energy about 2,500 foot-tons. The range was about 130 yards.

Three plates were submitted for trial: 1. A Schneider oil-tempered and hammered all-steel plate, said to have contained 3 per cent. of nickel; 2. A Vickers solid steel, rolled and hydraulic pressed, but untempered plate; 3. A Brown (Ellis) compound plate. The backing was 12 in. of pine timber well braced. A Kolpoui (Russian) compound plate, made under the Wilson patent, had been ordered for this trial, but for some reason was not ready for trial until some days later.

Five shots were fired at each plate, whose appearance at the end of the trial is shown in fig. 5. In this figure the through cracks are indicated by the letter "t." Briefly stated, the effects produced were as follows:

*Schneider Plate.*—None of the projectiles got their points through the plate. The maximum penetration was 11.4 in., the metal bending back beyond the back face of the plate. The minimum penetration was 9 in. Three of the projectiles rebounded, somewhat set up and two broke up. The plate was badly cracked, as is seen, the four corners being broken away, but held in place by the bolts.

The *Vickers Plate.*—Two of the projectiles lodged in the plate, their bases being 2 in. and 5 in. past the front face of the plate, with their noses presumably in the backing; three of the projectiles rebounded, one partially breaking up, the others in good condition. The minimum penetration was 11.75 in., the point of one projectile getting 3 in. beyond the back of the plate before rebounding. There were a number of through cracks, one corner being pretty well broken up.


FIG. 5. THE PLATES AFTER THE OCHTA TRIALS.

The *Brown Plate.*—The minimum penetration was 13 in.; two projectiles stuck in the plate, their bases projecting 2¾ in. and 3 in. from its face; three passed entirely through both plate and backing. There were a number of through cracks and some breaking away of the metal around the shot-holes.

center $A$ continue to describe arcs with radii $A$ 3′, $A$ 4′, $A$ 5′, etc., cutting the corresponding radii 3, 4, 5, etc., in the points $c$, $d$, $e$, etc. These will be points in the curve, which can then be drawn through them.

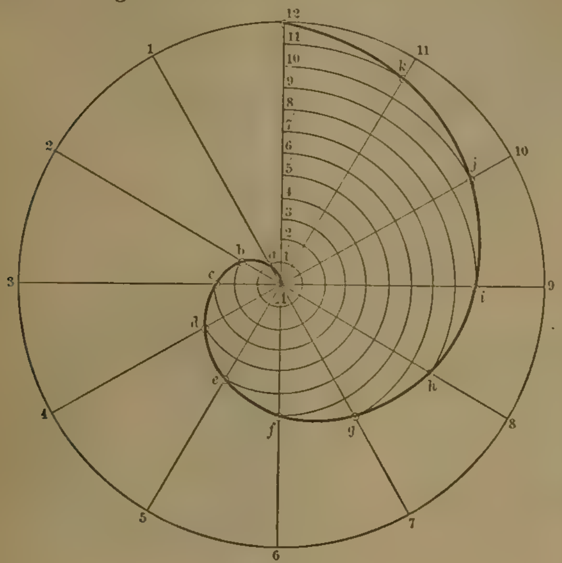



Fig. 272.

It is plain that a spiral of any number of revolutions around its center may be drawn by continuing it outside of the circle 1, 2, 3–12, by the method described.*

Problem 96. *To draw an approximate or false spiral.*

Lay off a central square $a$ $b$ $c$ $d$, fig. 273. Then from $d$ as a center and $d$ $A$ as a radius draw the arc $A$ $e$. Next with $a$ $e$ as a radius and $a$ as a center draw $e$ $f$. Again, with $b$ $f$ as a

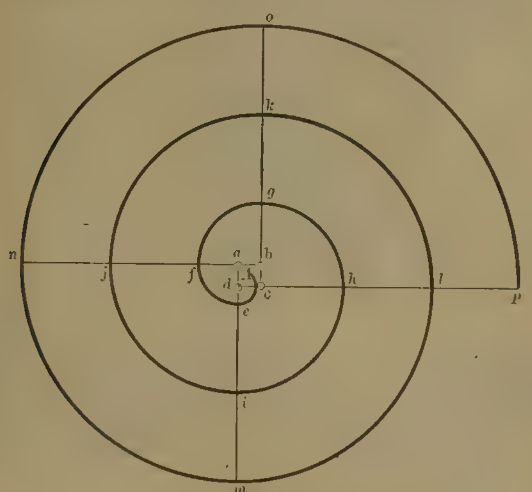



Fig. 273.

radius and $b$ as a center draw $f$ $g$, and with $c$ $g$ as a radius and $c$ as a center draw $g$ $h$. Continue in this way until the required number of revolutions of the spiral are completed.

THE INVOLUTE.

If a string is wound around a cylinder, $A$, fig. 274, and a tracing point o is attached to the free end of the string, it will describe a curve which is called the *involute* of a circle.

Problem 97. *To construct an involute of a circle.*

Let $A$, fig. 274, be the circle. Divide it into any number of equal parts—12 in the engraving—and draw radii from the points of division to the center $A$. From the extremities of these radii draw lines, as 1 1′, 2 2′, 3 3′, etc., perpendicular to the radii and tangent to the circle. Find the circumference of the circle and take one-twelfth of it in a pair of dividers, and set it off on the tangent line from 1 to 1′; then will 1′ be a point in the curve. Set off twice this distance from 2 to 2′, and 2′ will be another point. Continue in this way and set off successively on the tangent lines the number of parts corre-

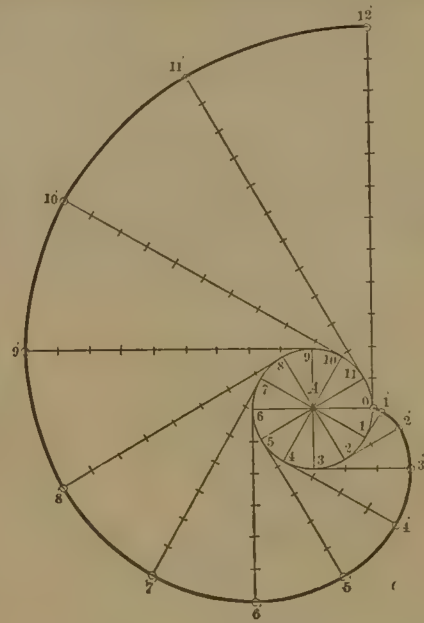


Fig. 274.

sponding to the number of the radius; then will 1′, 2′, 3′, 4′–12′ be points in the curve.

SPIRAL CAM.

Fig. 275 represents a cam whose outline is formed of two spirals. It possesses the property of giving a reciprocating piece of machinery a uniform motion.

Problem 98. *To lay out a spiral cam.*

Let $A$ $C$ $B$, fig. 275, represent the hub or boss of the cam and $C$ $D$ its stroke. First divide the circle $A$ $C$ $B$ into 12 equal parts, and draw radial lines through the points of division and the center, and extend them outside of $A$ $C$ $B$. Next divide the stroke $C$ $D$ into six equal parts. Suppose the curve begins at o and

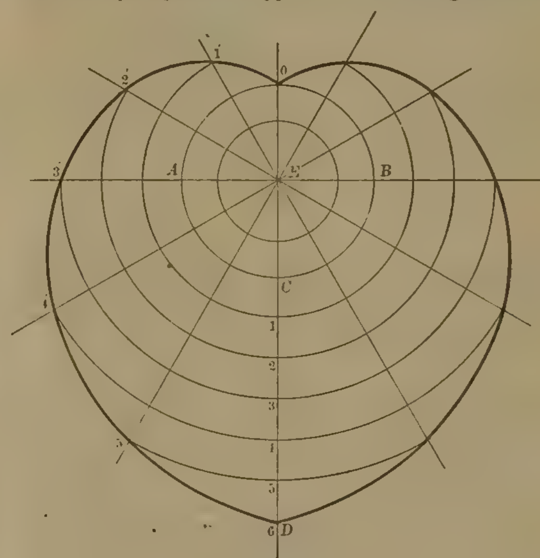



Fig. 275.

the reciprocating piece touches the cam at that point, then, with such a cam, the purpose is that the reciprocating piece shall be moved one-sixth of the stroke $C$ $D$, while the cam turns one-twelfth of a revolution. Therefore, from the center $E$ with a radius $E$ 1 draw an arc of a circle through 1 and cutting the radial line 1′. The point of intersection 1′ will then be a point in the curve. In a similar way draw arcs of circles through 2, 3, 4, and 5, intersecting the radial lines 2′, 3′, 4, and 5′. The outline of the cam may then be drawn through these points.

THE CARDIOID.

This curve may also be used for the outline of a cam.

* This figure and much of the elucidation of this problem have been taken from Ellis A. Davidson's "Linear Drawing."

PROBLEM 99. *To lay out a cardioid curve.*

Let *A B*, fig. 276, be the generating circle. Subdivide this into, say, 12 parts, and through one end o of a diameter o 6 draw lines o 1 1′, o 2 2′, o 3 3′, etc., intersecting the points of division of the generating circle, and extend the lines beyond the circle. Then take with a pair of dividers a distance equal to the diameter o 6, and from the point of division 1 in the generating circle lay off this distance, 1 1′ and 1 1″, on each side of 1. The points thus laid off will be in the curve. Proceed in a similar way and lay off from 2, 3, 4, etc., distances 2 2′, 2 2″, 3 3′, 3 3″, etc., which will give points in the curve through which it may be drawn.

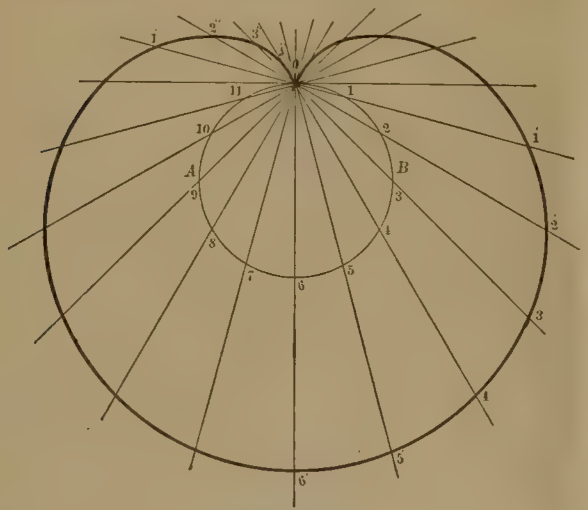


Fig. 276.

THE CISSOID.

PROBLEM 100. *To lay out a cissoid curve.*

Draw any line *A B*, fig. 277, and *C D* perpendicular to it. On *C D* describe a circle and divide it into a number of parts, in this instance 16. From the extremity *C* of the diameter draw lines through the points of division of the circle and meeting *A B*. With a pair of dividers take the distance *C* 1, intercepted within the circle, and lay it off from 1″ to 1′; then 1′ will be a point in the curve. Similarly take *C* 2 and lay it off from 2″ to 2′, and 2′ will be another point. Proceed in this way with the other lines drawn through *C* and the divisions of the circle, which will give points through which the curve can be drawn.

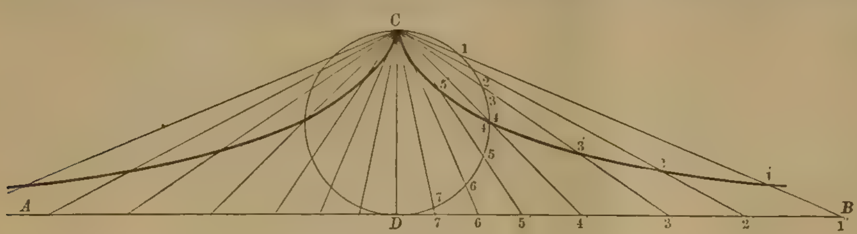


Fig. 277.

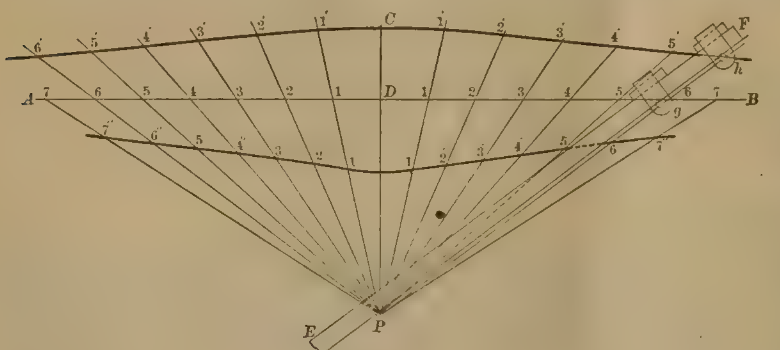


Fig. 278.

CONCHOID CURVE.

The *conchoid* is a curve which always approaches a straight line, but never reaches it, however far the curve and straight line may be produced. This curve has been used in drawing the slightly curved line which forms the outline of columns.

The straight line *A B*, fig. 278, is called the *asymptote*, *C D* the *diameter*, and *P* the *pole*.

PROBLEM 101. *To lay out a conchoid curve.*

The asymptote, *A B*, pole *P* and diameter *C D*, being given, draw *C P* at right angles to *A B*. On each side of *D* set off any number of equal parts, 1, 2, 3, 4, 5, 6, 7. From *P* draw lines passing through these points. From 1, 2, 3, etc., lay off distances 1 1′, 2 2′, 3 3′, etc., each equal to *D C*, and through these points draw the curve.

Another curve may be drawn below *A B* by laying off the distances 1 1″, 2 2″, 3 3″, etc., equal to *C D*. The curve above the asymptote is called the *superior conchoid*, and the one below it the *inferior conchoid*.*

A conchoid may also be drawn by means of a trammel, *E F*, as shown in fig. 278. A fixed pin is placed at the pole *P*, against which the trammel bears. A point *g* bears against a straight edge *A B*, and *h* is a tracing point. If the trammel bears against the pin *P*, while the point *g* is moved in contact with the straight edge, the point *h* will trace a superior conchoid. If *h* is placed below *g* it will trace an inferior conchoid.

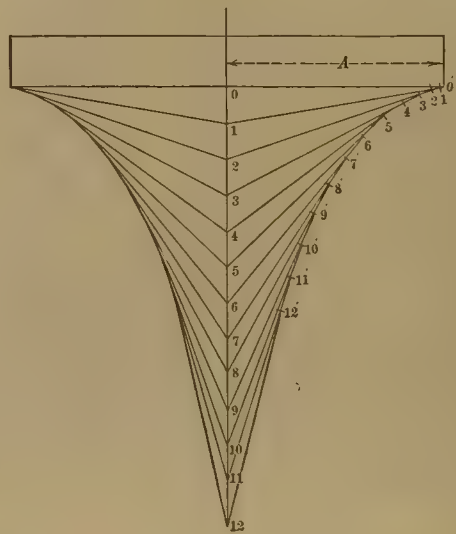


Fig. 279.

THE SCHIELE CURVE.

This is a curve which is named after its inventor, and was devised for the form of the bearings of revolving shafts to resist end thrust. Its object is to form a bearing which will wear uniformly.

PROBLEM 102. *To lay out a Schiele curve.*

After the dimension *A*, fig. 279, or half the largest diameter of the bearing is determined, divide the axis 0–12 into any number of equal spaces, 0 1, 1 2, 2 3, etc. Then set compasses to the dimension *A*, and from the point 1 describe an arc cutting 0 0′ at 1′, and draw a line 1 1′ through the point of intersection 1′. Then from 2 as a center, with a radius *A* describe an arc cutting 1 1′ at 2′, and again draw a line 2 2′ through the point of intersection. Continue in this way intersecting the preceding lines from the successive centers 3, 4, 5, etc., and the points 1′, 2′, 3′–12′ will be points in the curve.

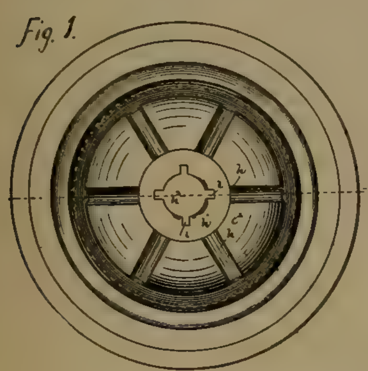
(TO BE CONTINUED.)

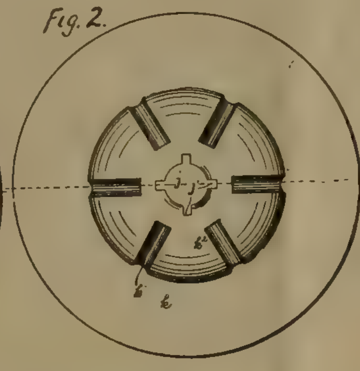
* From Ellis A. Davidson's "Linear Drawing."

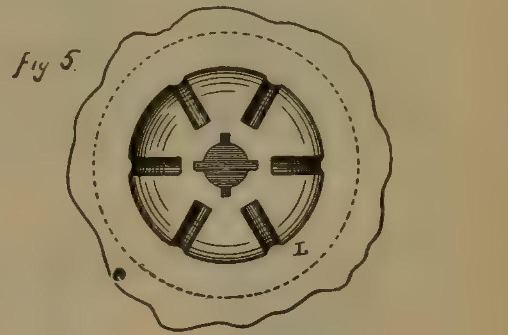
## Recent Patents.

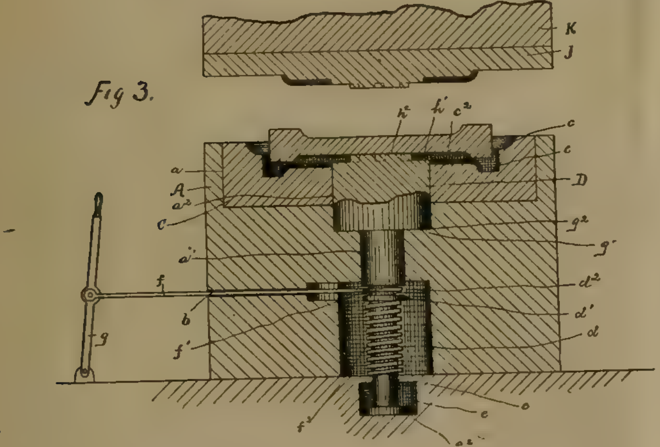
### BEACH'S MACHINERY FOR FORMING CAR WHEELS.

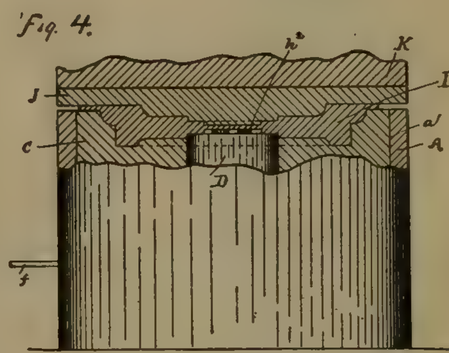
The accompanying engravings show machinery for forming car wheels from wrought iron or steel. Fig. 1 is a plan view of the anvil, lower die and ejector. Fig. 2 is a plan view of the upper or hammer die. Fig. 3 is a central sectional view of the anvil, lower die, ejector and hammer, taken on the dotted line of figs. 1 and 2, the dies being separated and a piece of metal being placed on the die ready to be swaged. Fig. 4 is a view, partly in elevation and partly in section, of the anvil and dies, the latter in closed position, with a swaged car-wheel blank in position. Fig. 5 is a plan view of the swaged car-wheel blank.




BEACH'S MACHINERY FOR FORGING CAR-WHEELS.

$A$ is the anvil, provided on its face with die-opening $a$ with vertical opening $a'$, extending downwardly through the anvil. Horizontal opening $b$ extends from said vertical opening to the periphery of the anvil. Anvil-die $C$ fits in said die-opening, and is provided with vertical opening $a^2$. Fitting in the latter opening is ejector $D$, the standard $d$ of which is provided with shoulder $d'$ and annular slot $d^2$. The lower extremity of said ejector fits in opening $e$, and is provided with shoulder $e^2$, adapted to engage with floor $e'$. Extending through horizontal opening $b$ is rod $f$, having its inner bifurcated extremity $f'$ engaging with annular slot $d^2$. Its outer extremity is pivoted to lever $g$, that is in turn pivoted to the mill-floor. Coil-spring $f^2$ surrounds said standard and has engagement at its upper extremity against shoulder $d'$ and at its lower extremity on the mill-floor. Annular shoulder $g'$ of the ejector has solid bearing when in lowered position against the annular shoulder $g^2$ of the vertical opening $a^2$.

Anvil-die $C$ has its face formed in several elevations, annular groove $c$ being most deeply depressed. In this the tread of the wheel is formed. In the next outer depression or annular groove $c'$ the flange portion of the wheel is formed. An annular projected web-forming portion $c^2$ is raised in relative relief above groove $c$ and surrounds or incloses the central projected disk portion $k^2$ and also face $k'$. This web-forming portion is provided with a series of radial grooves, $h$, which are in depth intermediate of the groove portions $c$ and the web-forming portion $c^2$. The face $h'$ of the ejector forms a part of this die and is flush with the web-forming portion of the same. Said face is provided with the projected portion $h^2$ and the four projected lug portions $i$. Corresponding disk and lug portions $j\,j'$ are respectively formed on the face of the hammer-die $J$, that is, attached to hammer $K$. Said disk and lug portions register with the corresponding parts on the anvil-die. Said hammer-die is further provided with the flat annular portion $k$, the radial rib-forming groove or depressed portion $k'$ and the projected web-forming portion $k^2$.

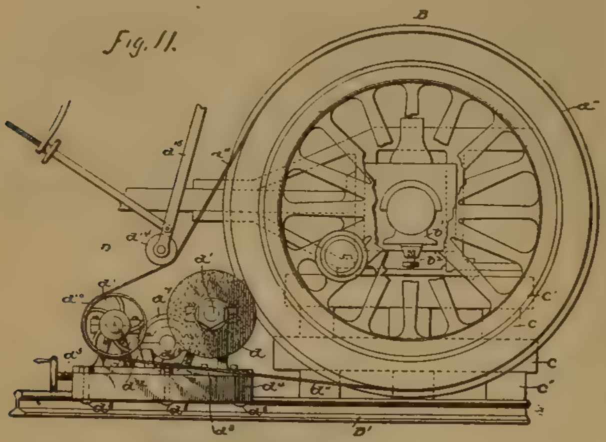
In operation a piece of metal of suitable size and of soft swaging-heat is placed on the lower die and thoroughly swaged by means of the upper die until it conforms to the form of the two dies when brought together, as shown by the blank $L$, figs. 4 and 5. When the swaging is completed, the lever $g$ is drawn back, thus releasing the bifurcated rod $f$ from engagement with the annular slot $d^2$ of the ejector. The spring $f^2$ is then free to exert its power, forcing upward the ejector and carrying with it in its upward movement the blank and releasing said blank from the die. Thereupon the blank may be removed and the operation repeated. The blank may then be finished in any suitable manner.

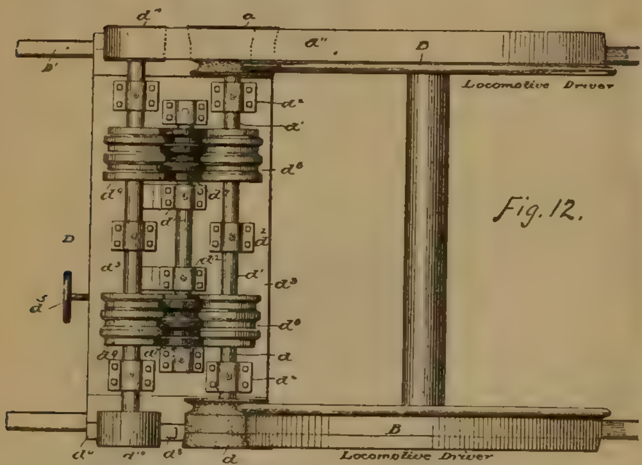
The inventor is Mr. Clifton B. Beach, of Cleveland, Ohio, and his patent is numbered 445,238.

### MEANS FOR TRUING LOCOMOTIVE WHEELS.

The aim of this invention, which is patented by Mr. Joseph Elder, of Peoria, Ill., is to true the driving-wheels or tires of a locomotive while they are in place on the engine and without taking it to a shop. To do this the engine is raised up so that its wheels are clear of the track and may be rotated by its own steam and driving machinery. To do this a portable emery grinder, shown in figs. 11 and 12, is placed on the track adjacent to the wheels to be trued. This is driven by belts $d''\ d''$, figs. 11 and 12, on the driving-wheels connected to pulleys either on the emery-wheel shaft, or, as in the engravings, to speeding gear; $d\ d$ are emery wheels attached to a shaft $d'$, and with its gearing it is mounted on a frame or bed-plate which rests on the rails and is attached to them with clip-bolts. The gearing is mounted on a slide rest which is moved by an adjusting screw $d^5$ by which the grinder can be brought up in contact with the tread of the wheel. The grinder-shaft $d'$ is provided with a grooved friction-pulley $d^6$, by which it receives motion through an idler $d^7$ from a driving-pulley $d^9$. The idler and driving-pulley are mounted on shafts in bearings on the plate $d^8$, and the shaft of the driving-pulley is provided with a band-pulley $d^{10}$, driven by a belt $d^{11}$, passing around the driving-wheel of the engine, so that when the latter is rotated it drives the grinder in contact with its surface. The idler-shaft is mounted in vertically-sliding bearings $d^{12}$, sustained by adjusting-screws $d^{13}$, to produce the required degree of friction be-

tween the pulley-surfaces. A belt-tightener $d^{14}$, mounted on lever $d^{16}$, or otherwise sustained, may be used, if required.




ELDER'S MACHINE FOR TRUING WHEELS.

The inventor says of his invention that its use results not only in a great saving of time and money, but renders it practicable to grind wheels frequently and thus keep them in good condition instead of allowing them, as usual, to run until they are badly worn.

The number of the patent is 449,350.

## The Evolution of the Coasting Ship.

(From the San Francisco *Bulletin*.)

It is more than 20 years since the first vessel with three masts and a fore-and-aft rig appeared in these waters. That vessel was built at Thomaston, in Maine, on an order given by A. P. Jordan, of Santa Cruz, then of the firm of Davis & Jordan, lime manufacturers and merchants. The vessel took the name of the junior partner. This was a small craft, a little under 400 tons, with flat floors and large carrying capacity. Except the extra mast there was no novelty about the vessel. She was employed for many years in the lumber and coal trade on the coast, and occasionally made a foreign voyage.

The Maine shipbuilders had begun to build large fore-and-afters. Those vessels became popular in the lumber, cotton and coal trade. They were mostly designed as coasters. The capacity was gradually increased, until vessels with this rig were constructed that would carry from 800 to 1,000 tons. That was supposed to be about the limit of a fore-and-after. Then the Maine shipbuilders added another mast and increased the tonnage. Some of the largest of these four-masters would carry as much as 1,500 tons. They were found to be profitable vessels, or the number would not have rapidly increased. In one small town in Maine last year, four vessels of this class were built. The carrying capacity has been gradually increased until the largest four-masters can carry about 2,000 tons.

The appearance of a five-master in this port with a carrying capacity of about 3,000 tons, on about half the registered tonnage, has attracted a great deal of attention as a sort of marine curiosity. It was assumed that this was the first five-master with a fore-and-aft rig that ever appeared in this port. But two years ago or more the Simpson Brothers, of this city, who are largely engaged in the lumber trade on this coast, built a five-master at Coos Bay. That was the *first* vessel ever seen in this port with five masts and a fore-and-aft rig. It was an odd-looking craft, and on her first appearance attracted much attention. The vessel carried no gaff-topsails, her masts were composed of a single stick; all the sails were handled from the deck. This vessel carried about two tons dead weight for each registered ton. She is not as large as the *Governor Ames.* Every few days the former vessel appears in port with a cargo of coal or lumber. The reports of her work here have always been favorable. She is an easy vessel at sea, a good sailer and a large carrier. As the Simpson Brothers, who launch several vessels every year, have not added another five-master to their fleet, the inference is that no particular advantage was found in adding this additional stick, especially if the vessels did not exceed 1,000 tons. Most of the vessels recently built by this firm have either had the barkentine rig or have had four masts with the fore-and-aft rig.

It is worthy of note that the same business in kind which brought into existence these large vessels in the Eastern States is stimulating the construction of this class of vessels on the Pacific Coast. The large four-master is no longer a novelty, nor is the vessel with the hybrid rig of square sails on the foremast and three fore-and-aft sails. The coal and lumber business on this coast is still in the early stages of development. It has already become an enormous business. A large fleet of vessels has already been constructed with reference to this coasting trade. From the harbor of San Francisco to Puget Sound vessels are on the stocks destined for the coal and lumber trade. A large exportation of lumber has already begun, which will rapidly increase in the future. Many of the vessels which have recently been put afloat are suitable for the foreign trade. The four-master of the largest size now takes a cargo ranging from 750,000 to 1,000,000 feet of lumber to Australian, South American, or Asiatic ports. A return cargo of some sort is found. The ventures increase.

Last year more lumber was exported from the Pacific Coast than in any former year. The coasting trade also rapidly increased. These two sources of business—the coasting trade and the export trade in lumber—will greatly stimulate the building of wooden ships on this coast. It is reported that the *Governor Ames* will hereafter be employed here in the coal and lumber trade. When, some months ago, a full-rigged ship went out of this port carrying about two million feet of lumber, it was considered an extraordinary circumstance. But this vessel with five masts, which, in common parlance, is not classed as a ship, has an equal capacity.

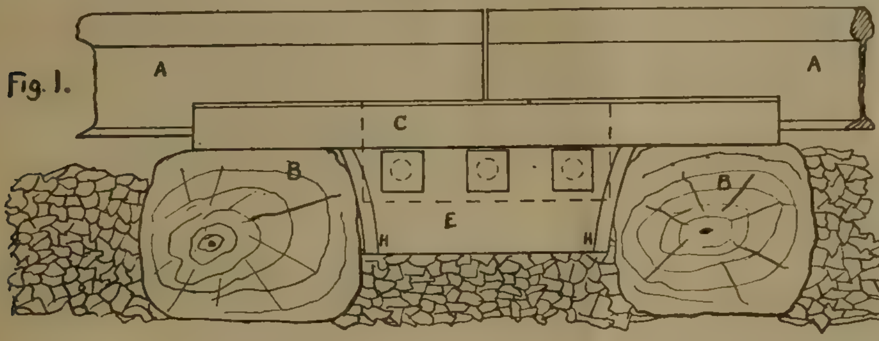
Vessels of this particular class may not be greatly multiplied here. But it is certain that the large fore-and-aft vessel, say with four masts, has the call. It is a marine evolution created by the demands of business, just as the same class of vessels was created in the Eastern States to meet the demands of business up and down the Atlantic Coast. This evolution is also, to some extent, a solution of the problem. How can the largest amount of dead weight or the largest number of feet of lumber be carried on long or short voyages at the smallest possible cost? At one time it was thought that the steam schooner was about to settle the question. But the evolution now is in the direction of the great fore-and-after, with a forest of masts and no auxiliary power.

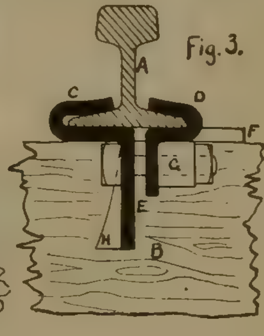
## Connell's Girder Rail Joint.

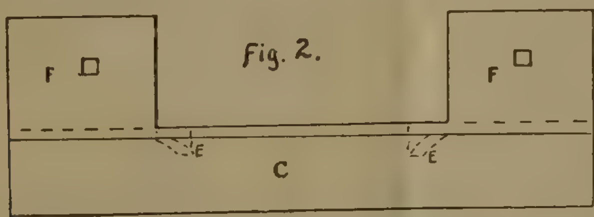
The joint, which is shown in the accompanying illustrations, is intended to serve not only as a connection for the rails, but to furnish a support underneath the joint, which will prevent any sagging of the ends of the rails, and will give the joint a carrying power equal to any other portion of the rails. Fig. 1 is a side view of the joint, fig. 2 a cross-section, and fig. 3 a plan of the main plate, showing the manner in which it is made to serve as a tie-plate, as well as a joint.

This main plate or member of the joint is proportioned in its sectional area to carry between the ties the heaviest driving-wheel load, with an allowance added for the effect of impact, the calculation being made with the unit stresses used in bridge construction, and without depending upon the projecting rail-ends for the support of any portion of the load. It will be seen that it is so arranged that the flange or carrying part *E E* is in line, and practically continuous with the web of the rail *A*. This carrier is a steel plate bent down in the shape shown in figs. 1 and 2, and deriving additional stiffness from the flanges at each end of the vertical portion, which also serve to give it an additional bearing on the ties. At each end of the

plate is a projection, *F*, which serves as a tie-plate, and through which a spike can be driven to prevent all movement of the rail. The second plate *D*, which is called the liner, is placed on the inside of the rail, bringing the nuts of the joint-bolts inside the track, where they can be conveniently inspected and tightened, if necessary, by the trackman. It will be seen that the bolts come underneath the rail, and that by means of the




CONNELL'S GIRDER RAIL JOINT.

washers *G* the nuts are brought out where they can easily be reached, and where the trackmen can apply their wrenches without difficulty.

The entire joint, it will be seen, consists of the two steel plates and three bolts. The bolts being placed beneath the rail, no punching or drilling of the web of the rail is required, nor is there any notching of the rail flanges. It can be applied to any weight of rail from 56 lbs. upward, with a minimum change in construction, the only variable feature being the angle which the top of the rail-flange makes with the base. The inside member of the joint *D* makes and maintains the line of track. It is claimed for this joint, in addition to the advantages pointed out above, that it gives a large bearing surface, will resist wear, will keep the track in good surface, and also that in it the force which ordinarily produces creeping of the rail is utilized to increase the connection between the joint and the rail, by means of the camber put in the carrier-plate. This force is resisted by the bearing of the carrier on the rail-flange, and of the flanged web *E* against the cross-tie. The cost of the joint will not exceed that of the ordinary double angle-joint now used.

This joint is protected by patent No. 451,554, recently granted to the inventor, Mr. W. H. Connell, whose address is Wilmington, Del.

# Manufactures.

## General Notes.

ONE of the largest manufacturers of elevators in this country, located in Baltimore, Md., states that his firm has been using Dixon's graphite grease on elevators for the past two years and finds it superior to any lubricant before used for that purpose. They also use it on wire cables to prevent rust and on elevator guides.

IT is understood that a large steel plant is to be put up shortly at Ensley, Ala., by the Tennessee Coal, Iron & Railroad Company. The objection has always been made to Southern iron that it is not adapted to the Bessemer process, but at Ensley the Basic process is to be used.

RIEHLE BROTHERS, in Philadelphia, have recently received orders for a 10,000-lbs. iron tester for the Benedict & Burnham Company, Waterbury, Conn.; a 5,000-lbs. transverse tester for the New York Car-Wheel Works, Buffalo, N. Y.; a 3,000-lbs. transverse tester for the Albion Iron Works, Victoria, B. C.; a 2,000-lbs. cement tester for the City Engineer, Los Angeles, Cal., and a 1,000-lbs. cement tester for Paige, Carey & Company, Wheeling, W. Va. The Company has also recently sold a number of the Robie patent screw-jacks of 10 and 20 tons capacity to different parties, including Meyer & Company, Norfolk, Va.; W. G. B. Fitzgerald, Norfolk, Va.: Jones & Laughlin, Pittsburgh; Valk & Murdock, Charleston, S. C.; Worth Brothers, Coatesville, Pa.; Pulaski Development Company, Pulaski, Va.; Max Meadows Iron Company, Max Meadows, Va.; E. O. Norton, Binnewater, N. Y.; Lombard & Company, Augusta, Ga.; Weston Furnace Company, Manistique, Mich.

AT the annual meeting of the Consolidated Car Heating Company in Albany, N. Y., recently, the following officers were chosen for the ensuing year: President, Robert C. Pruyn, Albany; Vice-President and Treasurer, William G. Rice, Albany; General Manager, D. D. Sewall, New York; Mechanical Superintendent, James F. McElroy; Assistant General Manager, J. H. Sewall, Chicago; Secretary, Charles J. Peabody, Albany; Executive Committee, Robert C. Pruyn, William G. Rice, George Westinghouse, Jr., D. D. Sewall, James F. McElroy, and A. S. Hatch.

THE plan of carrying a lighting and heating tender on passenger trains devised by Mr. George Gibbs, Mechanical Engineer of the Chicago, Milwaukee & St. Paul, has been heretofore described. This tender carries a boiler which furnishes steam to heat the train and to run the dynamo engine. For this service Mr. Gibbs made experiments with several types of engines, but without satisfactory results in the main particulars. With one form of horizontal engine it was found impossible to avoid an irritating vibration which was transmitted throughout the entire length of the connected train. The adoption of the Westinghouse engine proved successful in every particular. The same Company is using a 50-H.P. single-acting compound engine in its lighting plant at the passenger station in Milwaukee.

THE Buffalo Railway Supply Company has removed its offices to No. 52 Exchange Street, Buffalo, N. Y.

IT is claimed that the largest carrier on the lakes is the steel steamer *E. C. Pope*, built by the Detroit Dry Dock Company. She has just delivered a load of 3,070 net tons from Lake Superior on 14 ft. 1 in. draft; on 16 ft. draft she will carry 3,800 tons. The *E. C. Pope* is 337 ft. long over all, 42 ft. beam, and 24 ft. depth of hold.

THE American Steel Barge Company is extending its operations to the Atlantic. The steam whale-back barge *A. D. Thompson*, which was launched at West Superior, Wis., June 6, is the thirteenth of these barges now afloat. She has triple-expansion engines built in England, and is almost a duplicate of the *Charles W. Wetmore*, which has just left the head of Lake Superior for the Atlantic. The *Wetmore* will go direct to England with wheat. Her cargo of 70,000 or 80,000 bushels will be increased to about 100,000 bushels after the boat takes it on a second time at Montreal, it being necessary to go down the St. Lawrence rapids light. The *Wetmore* will probably go down the rapids in company with the *Colby* and her tow barge, as the latter is now delayed at Kingston for repairs to her boiler. The *Colby* and tow will engage in the Atlantic coast

trade for the present, and may be sent around the horn to the Pacific in the fall. These barges are 265 ft. long, 38 ft. beam, and 24 ft. deep, and their dimensions are of interest, as they show the largest boat that can reach the Atlantic from the lakes by going through the locks of the Welland and running the rapids of the St. Lawrence.—*Cleveland Marine Review.*

THE Safety Car Heating & Lighting Company, of New York, states that all apparatus placed by it on cars is fully covered by patents which it owns, and the Company is ready to protect purchasers of its apparatus in case of suit. An appeal has been taken from a recent decision of the Examiner in the Patent Office, affecting the use of circulating pipes; the Safety Company claims, however, that in any event its system will not be affected.

A NEW method of unloading coal, iron ore and similar freight from vessels has been introduced at Hamburg, Germany, by Mr. G. Blumcke. The hoisting shafts carrying grooved friction spools are bolted alongside of the hatches and are driven by small Westinghouse engines placed temporarily on the deck, the engines being on portable pedestals.

THE Delaware Ship Building Works have recently completed a new steamer, the *Costa Rica*, for the Pacific Mail Steamship Company. This ship is 250 ft. long, 36 ft. beam, and 20 ft. depth of hold. Her engines are of the triple-expansion type, with cylinders 20 in., 32 in. and 50 in. in diameter and 36 in. stroke. Steam is supplied by four boilers of the Scotch type. The *Costa Rica* will for the present run between New York and Colon.

AN order recently received by Riter & Conley, in Pittsburgh, is for 10 upright tubular boilers each 10 ft. in diameter and 30 ft. high for the new steel works at Superior, Wis. These are probably the largest boilers of this class ever built.

THE McConway & Torley Company, in Pittsburgh, is enlarging its office, requiring additional room. This Company recently shipped to one party 10 car loads of Janney couplers.

THE largest pair of rolls ever made in Pittsburgh were recently completed at the Phœnix Works in that city. They are 25 ft. 5 in. in length and 24 in. in diameter, and are intended for a plate-bending machine at the Mare Island Navy Yard.

IT is stated that the Lafayette Car Works, Lafayette, Ind., will be removed to Lima, O., and consolidated with the car works there under the name of the Ohio Car Company.

THE Southern Pacific Company is altering one of its consolidation engines to a compound engine. The engine, which was built at Schenectady two years ago, will be converted into a two-cylinder compound provided with the Pitkin intercepting valve. The cylinders will be 20 and 26 in. in diameter by 26 in. stroke. The driving-wheels are 56 in. in diameter and the engine weighs 133,000 lbs.

THE Harlan & Hollingsworth Company have recently completed a new steamboat, the *Montauk*, for the line between New York and Sag Harbor. The *Montauk* is 175 ft. long and 31 ft. beam and 11 ft. depth of hold. She has a surface condensing beam engine with cylinders 38 in. in diameter and 9 ft. stroke, with Stevens cut-off and proportioned to carry a working pressure of 60 lbs. The paddle wheels are iron feathering wheels 20 ft. 6 in. in diameter and 8 ft. face.

## Norfolk Improvements.

THE Norfolk & Western Railroad is now building in Norfolk, Va., a new passenger station and freight house, which will cost about $250,000. The Company is also completing its belt line around the city, and is building an engine-house and repair shop at Lambert's Point. In connection with this belt line the docks at Lambert's Point are to be extended and a large grain elevator is to be put up there. It is also expected that a special dock will be built there for unloading Cuban ores, which will be transported over this road, and used in some of the furnaces along the line for mixing with West Virginia and Virginia ores for the manufacture of Bessemer pig iron.

## Boilers and Stay-Bolts.

IN shops for the construction and repair of locomotives, it is well known that in many instances the most troublesome jobs in hand are the drilling and tapping of stay-bolt holes and the removal and replacing of old and broken stay-bolts. Having this in view, Mr. J. T. Connelly, of Milton, Pa., a boiler-maker of long experience, has devised some ingenious tools for this purpose. These include radial taps, which are especially adapted for tapping holes which are long distances apart, as, for instance, from the outer shell of the boiler to the crown-sheet, or from side to side. The device for tapping the holes is shown in fig. 1 herewith, in which *A A* are two corresponding screw-taps provided with exterior threads *a* and having a central bore extending entirely through the taps and provided with a thread. Through this central bore there is passed a spindle *C*, externally threaded to correspond to the bore *B*.

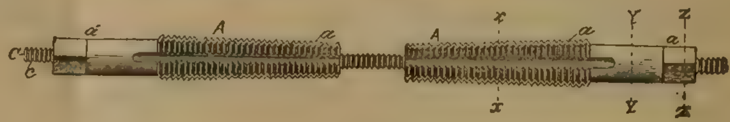


Fig. 1.

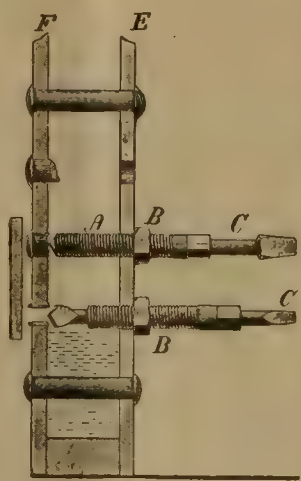


Fig. 2.

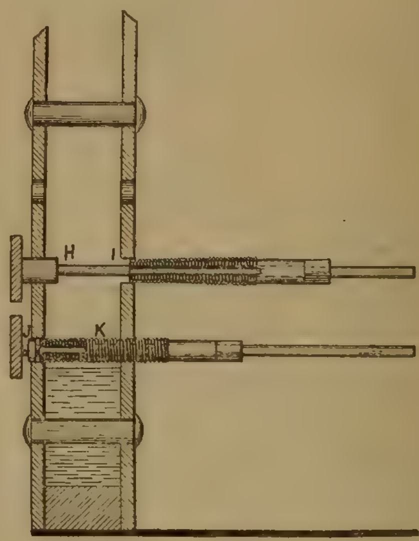


Fig. 3.

CONNELLY'S STAY-BOLT DRILLS AND RADIAL TAPS.

This spindle may be of any desired length, and the screw taps *A A* are mounted upon it, as shown, being thus adapted to work toward each other and to be guided by the spindle in a straight line. In operation this may be used by two men at the same time, one working from the inside and the other from the outside. One tap is secured upon the spindle far enough to have a firm bearing, and the spindle *C* is then passed through the holes to be threaded until the end of the tap enters the adjoining sheet, and the other end extends or projects far enough from the hole in the other sheet to receive the other tap, which is then secured upon the projecting end of the spindle; the taps are run into the respective sheets and the bolt holes are threaded. The great advantage of this arrangement is that the taps are guided in a perfectly straight line, even where the holes are long distances apart, and the threads cut in both sheets correspond.

The second device is for drilling out or removing old or broken stay-bolts without displacing any parts of the engine, and is best shown in operation, as in fig. 2. Here there is used an externally threaded tubular guide *A* which is screwed into the thread of the old stay-bolt hole of the fire-box sheet, and made to approach the part of the bolt in the outer sheet. The portion of the broken bolt in the fire-box sheet can be readily removed in the usual way, as it is always accessible from the inside. The guide *A* will approach the portion of the bolt in the outer sheet in a straight line, as its direction will be determined by the thread in the inside sheet. When it has been screwed in far enough, or so as to approach the broken bolt end, it can be locked in position by the jam-nut *B*. The drill *C* is then passed through the guide and may be readily driven

to accurately drill out or remove the bolt. In case a drill with a larger point, which will drill out the full-size hole, is preferred, the drill stem may be passed through from the front end of the nut *B*. This arrangement is shown in the lower hole in fig. 2. It will be seen that even where the stay-bolts which are broken come inside the frames or other portions of the engine, no part will have to be moved as long as the inside of the fire-box is accessible.

Another device, which is shown in fig. 3, is intended to tap holes in the plates of locomotive boilers at points which are not accessible from the outside, a case which frequently occurs in actual practice. Here also the arrangement can best be shown in operation. The holes having been drilled, as has already been shown, the spindle with the enlarged end is placed in the holes to be threaded, the enlargement entering the hole in the outer shell. The taper-tap is then placed on the spindle, and the hole in the fire-box sheet is threaded from the inside. The enlarged end of the spindle fitting the hole in the outer sheet and the tap the hole in the inner sheet, the latter will be guided in a straight line and forced to cut a thread corresponding in direction and pitch with that of the outer sheet. When the hole in the fire-box is threaded, the tap and spindle are removed, and the spindle having the threaded end and round nut is substituted, the nut being placed in the hole of the outer sheet as shown. This affords a firm bearing for the spindle and will necessarily guide the plug tap in a straight line, at the same time allowing it to enter and cut its thread in the hole of the outer sheet until the end touches the round nut, when, by pulling back on the spindle and turning it, the nut will be unscrewed and dropped down by the side of the fire-box. The tap, however, will then have a firm bearing, and the threading of the outer hole can be completed. The threads will then necessarily be in a straight line and will correspond, the tap being guided by the thread already made in the fire-box sheet and by the nut in the outer sheet.

The saving in time and expense in making repairs on a locomotive by the use of these devices can readily be understood by those who have had similar work to attend to. These devices have been fully tested in practical use.

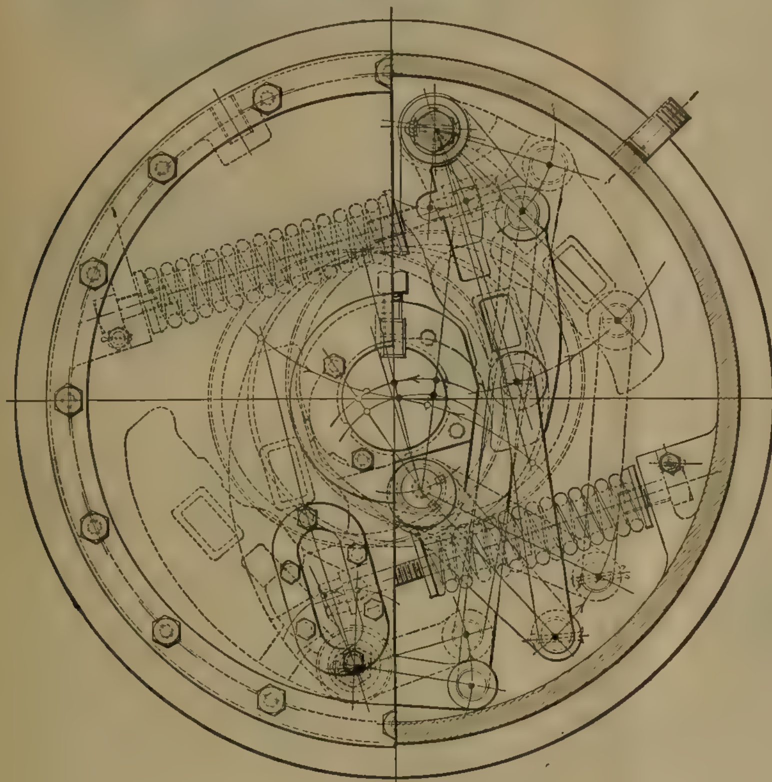


Fig. 2.

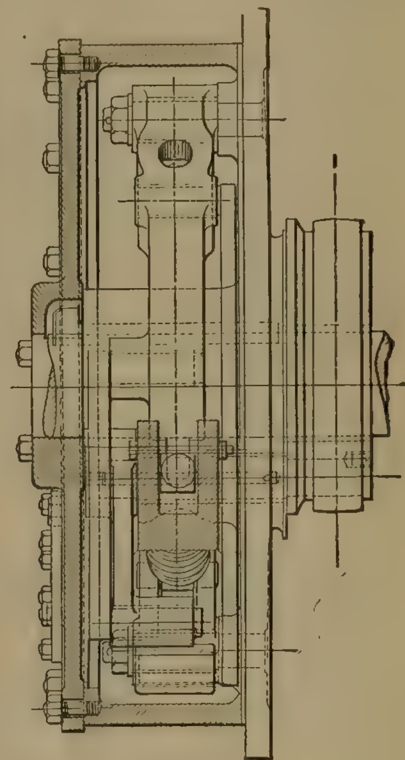


Fig. 3.

## The Westinghouse Governor.

THE chief points of excellence in a steam engine governor are its quickness of action and ability to handle the engine under great changes of load. In experimenting for a governor to meet these requirements the Westinghouse Machine Company has finally adopted one which, it is claimed, presents some points of advantage over any other now in use.

This governor is shown in the accompanying cuts, fig. 1 being a perspective view, showing the governor in use, running in a case filled with oil; fig. 2 a half plan and half section, and fig. 3 is a cross-section through the center, showing the position of the eccentric. These views show its simplicity of construction and the absence of the usual adjustments in the form of balanced eccentrics, unloading device, dash-pots, etc.

The details of the construction are shown by the drawings. A heavy unbalanced eccentric and strap place the center of gravity of the combination very near the center of the shaft without sacrificing strength. Short heavy springs with a low initial tension are used, and the governor is so compact that it is placed in a heavy case completely filled with oil, so as to

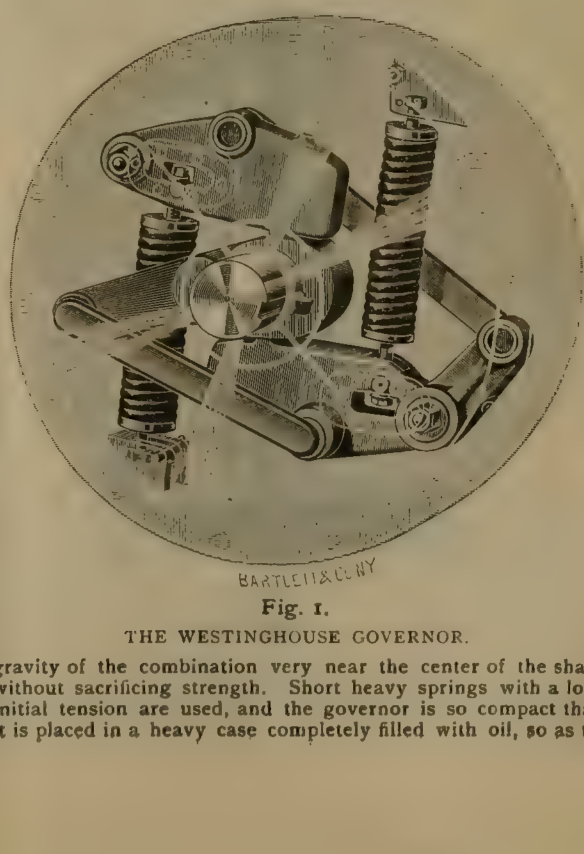


Fig. 1.

THE WESTINGHOUSE GOVERNOR.

insure free lubrication. While it is heavy and perfectly free to move even through the whole range, if necessary, its strength is a variable quantity and the leverage increases so as to meet and resist the greater strains of longer cut-offs. The chief excellence of the governor, it is claimed by the makers, is its ability to utilize its inertia for the rapid adjustment required to meet instantaneous changes of load. The tendency of the engine to change its speed as demanded by the regulation on account of change of load throws the governor to the new position to suit the new load, the inertia being the force which changes the adjustment of the governor. In this point it differs from other devices of this class, which are usually actuated by changes of centrifugal force alone, and consequently require heavy fly-wheels to keep them from raising under sudden changes. In this governor the centrifugal force is merely auxiliary, and the fly-wheel becomes simply a balanced wheel. It is no longer required in storing energy to delay the change of speed and give time for the governor to act.

A very severe test was recently made with this governor on a Westinghouse compound engine with cylinders 18 in. and 30 in. × 16 in. at the station of the Pleasant Valley Electric Railroad Company in Allegheny City, Pa. The cards taken from this engine under constant load, under partial changes, and under extreme changes show a remarkable uniformity, and it was estimated that the governor would travel over the entire range corresponding to a change of the capacity of the engine of 250 H. P. in less than three seconds. This governor is especially adapted for use in engines for an electric plant, where the changes in power are very sudden and very great.

## The Topliff Safety Attachment for Valves.

THE accompanying illustrations show a safety attachment for check-valves, water-gauges and other boiler attachments, which has been devised and invented by Mr. Judson B. Topliff,

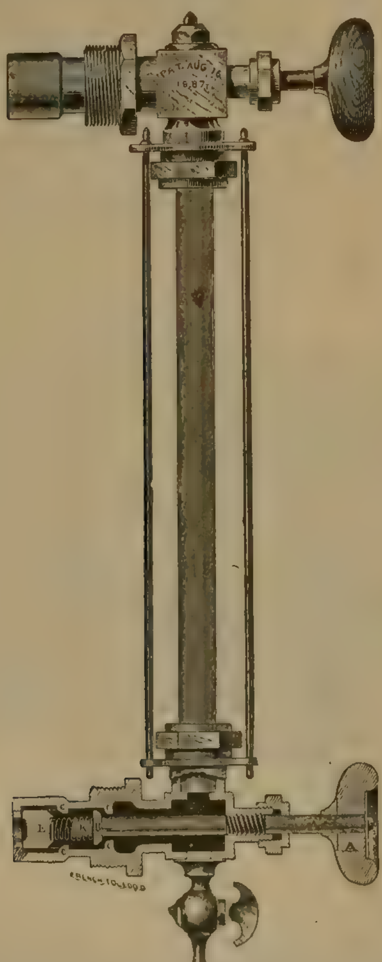
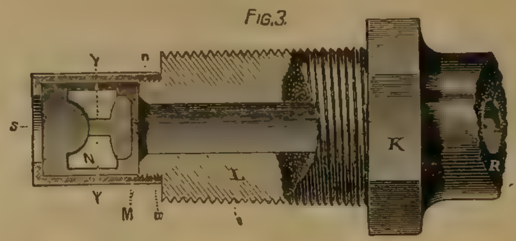
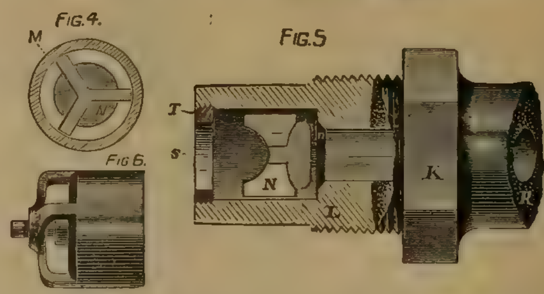



Fig. 1.

of Toledo, O. Fig. 1 shows a glass water-gauge provided with this attachment, while figs. 3, 4, 5 and 6 show different forms of the valve upon a larger scale. The idea will be readily seen from the illustrations. It is to provide a supplementary valve which, in case of the breaking of the gauge, check-valve, or other attachment in any way will be at once automatically closed by the greater pressure of steam in the boiler, and will thus prevent any escape of steam. It is well known that in




TOPLIFF'S SAFETY ATTACHMENT FOR VALVES.

case of an accident to an engine much damage and injury to persons frequently results from the steam and hot water which escape at points where the boiler attachments are broken or wrenched off, but by this arrangement such injuries would be entirely avoided.

An incidental but considerable advantage is that leaky cocks can be ground in while steam is in the boiler, the inside valve closing at once when the outer portion of the valve is removed. It is also claimed by the inventor that in a check-valve this attachment will increase the capacity of the injector considerably and the valve will not become useless from corrosion, mud or any sediment in it, since the valve will remain closed except when the injector is working and no sediment from the boiler can be forced into the check. This claim has been substantiated by actual experience on a locomotive.

The advantages of this arrangement will readily be seen by practical men, and the device seems well adapted for the purpose for which it is intended.

## Brake Shoes.

IT might be of interest to readers to know that wood brake shoes were used by railroads in their earlier days.

Wood brake shoes were in general use on the Baltimore & Ohio cars, with the exception of iron coal cars, from its opening until about 1853. The shoes were principally of ash, but oak was used to some extent.

After the line crossed the Alleghanies it was soon discovered that wood brake shoes would not answer, as they burned out while descending the heavy grades, and a wrought-iron shoe riveted to a cast-iron block superseded the wood shoe. The wrought-iron shoe has since been superseded by the cast-iron shoe for passenger and freight equipment.

## Baltimore Notes.

A CERTIFICATE of incorporation of the Maryland Bolt & Nut Company of Anne Arundel County has been filed in the office of the clerk of the Circuit Court, at Annapolis. Following are the incorporators: David L. Bartlett, J. Olvey Norris, W. F. Frick, C. A. Hotchkiss, Thurston Rawlins, Howard Carlton, and George A. Von Lingen. The location is Curtis Bay. The capital stock is $100,000.

THE Baltimore & Ohio Railroad has just closed a contract with the Pullman Company for 36 first-class coaches and 6 combined passenger and baggage cars.

THE Wells & French Company, Chicago, is building 75 gondola cars of 60,000 lbs. capacity for the Pittsburg & Chicago Gas Coal Company.

THE South Baltimore Car Works, Curtis Bay, have just closed a contract with the Youghiogheny River Coal Company for the construction of 200 hopper gondolas of 60,000 lbs. capacity.

THE compound engine built by the Baldwin Locomotive Works for the Baltimore & Ohio is now in Mt. Clare shops, being changed to a simple engine.

THE Baldwin Locomotive Works are building three new passenger engines for the Baltimore & Ohio Railroad, which are to have 78-in. wheels.

## The Baker Heater Company.

THIS Company has recently moved into a new and commodious building at 799 Greenwich Street, New York, which is equipped with the requisite machinery, tools, and appliances for manufacturing the well-known Baker Car Heater. This was invented in 1868, and was not materially improved until seven years ago, when Mr. Baker commenced making and putting into use various improvements which resulted in the production of a heater in which the fire is enclosed and completely enveloped within a soft flexible wrought-steel cylinder, which would be crushed, but cannot be broken in a collision. This cylinder is made by welding the longitudinal joint of the plates and also the two heads, thus making it practically jointless. This improvement is so obvious that it seems a wonder that all car heaters have not been made in this way long ago.

The new shop will give the Baker Company improved and increased facilities of manufacture, and new improvements in details are constantly being made in their apparatus.

After a long litigation in the Patent Office, occupying over three years, a decision has just been rendered in favor of W. C. Baker as the first inventor of the combination with a car "of a system of circulating pipes within said car, and two heaters both in operative contact with said circulating system, or with branches thereof, and adapted to be operated simultaneously or separately for imparting heat thereto."

## PERSONALS.

A. F. HARLEY has been appointed City Engineer of Jacksonville, Fla.

L. B. JACKSON has resigned his position as Chief Engineer of the Chesapeake & Ohio Railroad.

W. BARCLAY PARSONS has been appointed Assistant Engineer of the New York Rapid Transit Commission.

GEORGE H. BAKER has been appointed Fuel Expert of the Southern Pacific Company, with headquarters in Sacramento.

ALFRED P. BOLLER, of New York, the well-known bridge engineer, has been elected a member of the British Institution of Civil Engineers.

W. H. HUDSON is appointed Master Mechanic of the Atlanta and the Brunswick Divisions of the East Tennessee, Virginia & Georgia Railroad, in place of E. M. ROBERTS, resigned.

N. W. EAYRS has been appointed General Manager of the Wheeling Bridge & Terminal Company at Wheeling, W. Va. He was recently engineer of the St. Louis Terminal Railroad.

WILLIAM H. V. ROSING has resigned his office as Assistant Master Mechanic of the Illinois Central Railroad, to accept a position with the new Grant Locomotive Works in Chicago.

EDWARD ELLIS succeeds the late Charles G. Ellis as President of the Schenectady Locomotive Works. WILLIAM D. ELLIS succeeds Mr. Edward Ellis as Treasurer of the Company.

A. C. BASSETT has resigned his position as Superintendent of the Coast Division of the Southern Pacific, and will take charge of the Loma Pietra Lumber Company in Southern California.

C. C. ELWELL has been appointed Engineer of Maintenance of Way of the Pittsburgh Division, Baltimore & Ohio Railroad, succeeding W. A. PRATT, who has been transferred to the Philadelphia Division.

W. A. STONE is appointed Master Mechanic of the Alabama Division of the East Tennessee, Virginia & Georgia Railroad, in place of C. L. PETRIKIN, who has resigned to engage in manufacturing business.

HARVEY MIDDLETON, late Superintendent of Motive Power of the Union Pacific, has been appointed Superintendent of Construction of Pullman's Palace Car Company, and will have his office at Pullman, Ill.

JAMES HARRINGTON has been appointed Chief Engineer and General Superintendent of the Cleveland, Akron & Columbus Railroad, and JOHN J. HENRY Superintendent and Master Mechanic. As Superintendent Mr. Henry succeeds R. G. SHARPE, who has resigned.

JOHN W. HOBART has resigned his position as General Manager of the Central Vermont Railroad. He has been connected with the road for 43 years, beginning as freight clerk, and holding successively the positions of Station Agent, General Freight Agent, General Superintendent, and General Manager. Mr. Hobart retires from business altogether.

THE following changes in the Engineer Department of the Navy have been directed by the Secretary: CHIEF ENGINEER H. B. NONES has been ordered to duty as a member of the Examining Board in Philadelphia; he is relieved at the League Island Yard by CHIEF ENGINEER A. S. GREENE; CHIEF ENGINEER WILLIAM W. DUNGAN is relieved from duty at the New York Navy Yard and placed on waiting orders. His place in the New York Yard is taken by CHIEF ENGINEER S. L. P. AYRES.

THE following changes on the Chicago, Rock Island & Pacific Railroad result from the death of Mr. Verbryck: GEORGE F. WILSON, heretofore General Master Mechanic, is appointed Superintendent of Motive Power and Equipment, and will have charge of the car department as well as of the motive power; H. MONKHOUSE, heretofore Assistant General Master Mechanic and Assistant General Master Car-Builder, is appointed Assistant Superintendent of Motive Power and Equipment, with headquarters at Horton, Kan., and will have charge of the Company's Southwestern lines; JOHN BLACK, JR., is appointed Master Mechanic of the Illinois Division, with headquarters in Chicago.

COLONEL CLARENCE H. HOWARD, for some time past General Superintendent of the railroad department of the Scarritt Furniture Company, St. Louis, resigned June 1 to accept the position of Vice-President and General Manager of the St. Charles Car Company. Colonel Howard is a graduate of Washington University, St. Louis; he is also a practical man, having learned the trade of machinist on the Union Pacific. He served the Missouri Pacific as Assistant Foreman and Foreman of the locomotive shops in St. Louis, and later as Assistant Master Mechanic, having been in the interval Superintendent of the Missouri Car Wheel & Foundry Company, and of the Kansas City Car & Wheel Company. He left the Missouri Pacific to connect himself with the Scarritt Furniture Company. Colonel Howard is widely known among railroad men, and wherever he is known is esteemed, as he deserves to be. Few men are more popular, and few can get through with a greater amount of work in a given time. His successor with the Scarritt Furniture Company is his brother, GEORGE E. HOWARD, recently with the Union Pacific.

## OBITUARY.

JAMES C. CONVERSE, who died in Greenfield, Mass., May 25, has been for some years past President of the National Tube Works Company, of Boston and McKeesport, Pa. He was for a number of years engaged in business in Boston, and was one of the founders of the successful concern now known as the National Tube Works Company. Mr. Converse was a leading advocate of the construction of the Hoosac Tunnel, and served one term as Railroad Commissioner of Massachusetts.

DAVID BROOKS, who died in Philadelphia, May 30, aged 71 years, was engaged with Professor Moss in his first experiments on the telegraph, and assisted in putting in operation the first telegraph line built in America. He was engaged in building new lines for a number of years, and in 1851 built the line between Vera Cruz and the City of Mexico, the first one in that country. For a number of years he was in the service of the Pennsylvania Railroad Company and afterward of the Western Union Telegraph Company, but since 1867 had devoted his time to inventions and improvements in telegraph and telephone service, many of which are in successful use. In 1873 he served as Commissioner to the Vienna Exposition.

CHARLES H. DUNHAM, who died in Chicago, June 3, was well known among railroad supply men, and had been engaged in a number of enterprises, the most successful of which was the introduction of the Dunham car door, with which, in connection with some other patent devices, he established a flourishing business, which was afterward transferred to the Q. & C. Company. Mr. Dunham then undertook the establishment of a great railroad supply agency on so extravagant a scale that it could hardly be expected to succeed. He was very popular among his wide circle of friends and acquaintances, being a very genial and generous man, but a lack of self-restraint prevented his final success.

B. K. VERBRYCK, who died suddenly in Chicago, June 2, aged 67 years, began work on the Erie, where he reached the position of Foreman in the old Piermont shops; he was afterwards for 26 years in the service of the Chicago, Rock Island & Pacific Railroad, and for a number of years past was Master Car-Builder of that road, having entire charge of its cars. Mr. Verbryck had been so long with the Rock Island Road that he was in a measure identified with that road, but was known throughout the country as an officer of ability and a man thoroughly versed in his business. He was a member of the Master Car Builders' Association from its early days, taking a prominent part in its proceedings. He served a year as Vice-President and one year as President of the Association.

COLONEL JOHN ALBERT MONROE, who died in Providence, R. I., June 11, had resided for many years in that city. He was 54 years old, and graduated from Brown University in 1860. He served during the war as an officer of artillery, attaining the rank of Colonel and Chief of Artillery of the Second Army Corps. After the war he took up the profession of civil engineering, and was engaged on many important works. In 1878 he was appointed Assistant Engineer to the Mississippi River Commission, and made complete surveys of the river from Cairo to Memphis. Later he had charge of the building of part of the West Shore Railroad, and built water-works for Bismarck, N. D., and several other cities. He was Resident Engineer in charge of the construction of the Thames River Bridge, which was his last work. He was one of the oldest members of the American Society of Civil Engineers, and took a prominent part in the proceedings of that Society.

CHAUNCEY VIBBARD, in his time one of the best-known railroad men in America, died June 5, at Macon, Ga., where he had gone for his health. He was 79 years old. He was born in Saratoga, N. Y., and at an early age became clerk in a store in Albany, and for several years was employed in business in that and other cities. In 1836 he was made Chief Clerk of the old Utica & Schenectady Railroad, then just completed, and held that position until 1848, when he was made General Superintendent of the road, of which Erastus Corning was then President. In connection with Mr. Corning he arranged the consolidation of the companies owning the different links of railroad between Albany and Buffalo, which resulted in the formation of the New York Central Company in 1853. Mr. Vibbard was made General Superintendent of the consolidated line and held that position until 1865, when he resigned and removed to New York, where he has since resided. For a number of years he was actively engaged in business there, but retired some years ago, although he retained an interest in various enterprises, including the Day Line of Steamers between Albany and New York, and a number of Southern railroads. From 1861 to 1863 Mr. Vibbard represented the Albany district in Congress, and for a short time in 1862 he was Director of Military Railroads, resigning that position, however, as soon as the War Department had completed its railroad organization. It is Mr. Vibbard's great distinction that he was one of the first to see and recognize the necessity of consolidation, in order to secure the proper and economical management of the great through lines to the seaboard, and that he also foresaw before almost any other railroad man in the country the great decrease in railroad rates which was coming, and realized that it could only be met by corresponding economy in transportation. He was at one time a very wealthy man, but leaves only a moderate fortune.

## PROCEEDINGS OF SOCIETIES.

**National Convention of Railroad Commissioners.**—The Committee on Safety Appliances appointed at the last convention has decided that information on the following subjects should be obtained:

The total number of freight cars owned, leased, or otherwise controlled by each company, and how many are equipped with automatic couplers.

The kinds of couplers used, and the number of cars with each kind.

The kind of couplers each company now causes its freight cars to be equipped with.

The number of freight cars each company has equipped with train brakes, and the names of the brakes used.

The number of locomotives each road owns, leases or controls, and the number equipped with driving-wheel brakes.

The opinion of railroad officials as to the way in which the equipment of freight cars with uniform automatic couplers can best be hastened.

The Committee has also determined that a circular setting forth the resolutions of the Convention under which the Committee is acting, and requsting such information, be sent to all railroad companies engaged in carrying Interstate commerce.

It has also determined that another circular embodying the resolutions above referred to be sent to organizations of railroad officials or employés with the request that any communications which they may desire to submit in relation to the subjects covered by the resolutions be sent to the Committee in care of Edward A. Moseley, Secretary, at the office of the Interstate Commerce Commission, Washington, D. C., and should a hearing be desired by any organization to notify the Committee thereof on or before August 1.

The next meeting of the Committee will be held in New York, November 10. Mr. George G. Crocker, of the Massachusetts Commission, is Chairman, and E. A. Moseley Secretary.

**Association of Railroad Accounting Officers.**—The third annual convention was held in St. Louis, May 27 and 28, about 150 members being present.

Reports were received and acted upon from freight, passenger and other committees. Among other things, a modified plan of settlement of joint freight accounts, based on the plan adopted by the association two years ago, and known as the Niagara Falls plan, was adopted.

Addresses were read to the convention as follows:

W. K. Gillett, Proper Checks for Auditing Daily and Monthly Reports of Local Passenger Traffic.

E. R. Murphy, Materials Account—Proper Relation of Accounting Departments Thereto.

Officers were elected for the ensuing year as follows: Cushman Quarrier, Louisville & Nashville, President; D. A. Waterman, Michigan Central, First Vice-President; Chauncey Kelsey, Chicago & Alton, Second Vice-President; C. G. Phillips, Chicago & Northwestern, Secretary and Treasurer. To take the place of retiring members of the Executive Committee the following were elected: G. W. Booth, Baltimore & Ohio; G. L. Lansing, Southern Pacific Company; M. Riebenack, Pennsylvania Railroad; Carlton Hillyer, Georgia Railroad.

**Master Car-Builders' Association.**—The Annual Convention met at the Stockton Hotel, Cape May, N. J., 97 members answering to the opening roll-call. After a short address by the Mayor of the City, the President, Mr. John Kirby, delivered his annual address, in which he referred to several points requiring the attention of the Convention, among which he included the diversity of design of the M. C. B. type of couplers coming into use, the excessive use of defect cards, the progress made in equipping freight cars with automatic brakes and couplers. He also referred appropriately to the recent death of ex-President Verbryck.

The Secretary reported that the Association now has 278 members, of whom 158 are active, 115 representative, and 5 associate members. Mr. H. G. Prout and Mr. D. L. Barnes were elected associate members. The President then appointed committees to nominate officers, to report subjects, to audit accounts, and on correspondence and resolutions.

The Joint Committee on Time and Place of Meeting reported that they had agreed to recommend a change in the constitution of both associations, arranging that the Master Car Builders' Association meet on the second Wednesday in June, and the Master Mechanics' Association on the Monday following; the place of meeting to be fixed by the officers of the two associations acting jointly. The report was approved and the necessary resolution adopted.

Reports were then presented by the committees on Lettering Freight Cars, on Steam Heating and Ventilation, and on Pressed Steel and Malleable Iron in Car Construction. The last-named report presented some statements as to the use of steel and some tests of strength of malleable iron, and its report was discussed at considerable length. It was resolved

that a Committee be appointed to report to the next Convention a standard for stake pockets, and one for pressed steel center-plates for car trucks.

The other reports were accepted and the Committee on Steam Heating was directed to report a standard connection between the hose and pipe and a standard location for the end of the steam-pipe.

On the second day a Committee was appointed in response to a communication received from the officers of the Columbian Exposition to consider the question of co-operation of the Association. The rest of the meeting was devoted, according to custom, to the discussion and amendment of the standard rules for interchange, the principal points brought up this year being in relation to defective wheels and wheel guarantees ; to the maintenance of standards for M. C. B. standard coupler and to air-brake standards and the inspection and care of air-brakes on freight cars. The last named was of the most importance, in view of the rapid increase in the number of cars furnished with air-brakes.

At the third's day's session resolutions were adopted in favor of co-operation of the Association in the great Exposition at Chicago.

The Committee on Wheel Guarantee presented a report stating that no conference had been held with the Wheel Makers' Association. The Committee was continued to report at the next meeting of the Association. The Committee on Metal for Brake-shoes was also continued, Mr. J. N. Barr being added to it.

The report of the Executive Committee on the Standard Coupler was discussed at some length, and it was resolved that the Executive Committee be authorized to make the necessary arrangements for supplying templates for the use of railroads and manufactures of couplers. A resolution was also adopted for the appointment committee to consider whether any changes from the present limits would be advisable.

It was resolved to submit to letter-ballot the form of journal-box and bearing for 60,000-lbs. cars submitted by the Committee.

A number of places were suggested for the next meeting, including Cleveland, Alexandria Bay, Saratoga, Lakewood, N. Y., and Boston.

The usual resolutions of thanks, etc., were adopted, and committees were appointed to prepare suitable memorials of Mr. B. K. Verbryck and B. C. Richardson.

The officers chosen for the ensuing year are : President, John Kirby ; First Vice-President, E. W. Grieves ; Second Vice-President, J. S. Lentz ; Third Vice-President, T. A. Bissell ; Treasurer, G. W. Demarest ; Secretary, J. W. Cloud ; Executive Committee, R. C. Blackall, E. Chamberlain, F. D. Casanave.

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**Master Mechanics' Association.**—The Annual Convention met at Cape May, N. J., June 16. An opening address was delivered by Congressman Reyburn, of Pennsylvania. The opening roll call showed 107 members present.

The President, Mr. John Mackenzie, delivered his annual address, in which he urged the necessity of further efforts to decrease the cost of transportation. The object of the motive power officer should be to make locomotives more economical in the use of fuel, and at the same time have them pull heavier trains. He also called attention to the need of action on safety appliances for locomotive and cars.

The Secretary reported that there were now on the roll 14 honorary, 430 active, and 14 associate members, the increase in members last year being the largest ever made in any one year. The usual committees were appointed.

The Committee to confer with the Master Car Builders' Association reported an amendment, the same as that submitted to the other Association, which was adopted. It provides that the Master Car Builders' meet the second Wednesday in June and the Master Mechanics on the Monday following, the place of meeting to be determined by the officers of the two Associations, acting jointly.

A resolution was adopted providing for the incorporation of the Association under the laws of New York.

Mr. Charles B. Blackwell read a paper on Flanging Steel at other than red heat, which called out considerable discussion. He presented some remarkable samples of flanged steel.

The Committee on Exhaust Pipes, Nozzles and Steam Passages presented a report which was accompanied by a number of drawings and indicator diagrams taken from locomotives on the Richmond & Danville and the Cincinnati Southern roads. The Committee recommended that the exhaust-pipes should be so arranged as to make the exhaust as free as possible and avoid back pressure ; that the discharge should be nearly central with the stack, and that the exhaust-pipe should terminate at such distance from the base of the stack as to insure its being completely filled at each discharge. A taper stack was recommended. This report also called out a long discussion in which a great variety of practice was indicated, as usual.

The Committee on the Advantages and Disadvantages of Placing the Fire-Box above the Frames asked to be discharged, which was done.

At the second day's session, the Committee on Iron and Steel Axles presented a report, submitting the facts collected, but declining to make any positive recommendations. This report was also discussed, but without reaching any conclusions. The report of the Committee on Testing Laboratories for Railroads was presented. It recommended the use of such laboratories in charge of proper officers as Engineer of Tests and Chemist, and gave estimates as to the cost of the necessary machinery. Instances were given of the saving secured in many cases by careful tests of materials purchased. Quite a lively discussion was held over this report.

The Committee on Disposal of the Boston Fund recommended the establishment of scholarships at the Stevens Institute, Hoboken, on the terms offered by that Institution. The report was adopted and the officers directed to carry out its recommendations.

When the hour for general discussion arrived Mr. Vauclain addressed the Association on Compound Locomotives, and was followed by other speakers, much interest being taken in this subject.

The Committee on Purification of Feed-Water then presented its report, which was briefly discussed, Mr. Gibbs giving some facts as to the great gain secured by purifying bad water.

The Committee on the M. C. B. Standard Coupler presented a verbal report, which was received, and the Committee continued. A resolution was adopted in favor of the use of the vertical plane coupler.

The Committees on Examination of Engineers and Firemen, and on Operating Locomotives with Different Crews, presented reports which were received and laid over for further discussion.

At the third day's session there were brief discussions on both these reports, and a report was presented by the Committee on Locomotives for Heavy Fast Service. This presented the results of information collected, and stated that the preference appeared to be for the use of a ten-wheel rather than a mogul engine for such service, but declined to make any positive recommendation until further experience had been had with this type of engines, which had only been for a short time introduced on passenger trains.

The following subjects for discussion for next year were reported and approved :

1. Locomotive Indicators.
2. Compound Locomotives.
3. Special Tests and Investigations.
4. Uniform Standard of Comparison for Locomotive Performance.
5. Couplers.
6. Exhaust-Pipes and Nozzles.
7. Electric Appliances.
8. Air-Brake Rules.

Mr. John Mackenzie was re-elected President and Angus Sinclair Secretary, with the other officers of last year.

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**New England Water-Works Association.**—The 10th Annual Convention began at Hartford, Conn., June 10, with a large attendance. President A. P. Noyes delivered the annual address, stating that the Association now has 360 members, and is in a prosperous condition, having a balance of $2,000 in the treasury. After the routine business had been transacted, the Committee on Classification of Rates presented its report, and Mr. Freeman C. Coffin read a paper on Standard Flanges for Water-pipes.

At the evening session papers on experience with the Water Hammer, by E. E. Farnham, and on Lead Pipe Connections for Iron Service Pipe, by H. G. Holden, were read and both were discussed. Discussions were also held on several topics suggested by members. After the meeting reception was given to the members at the Allyn House.

On the second day, Thursday, a portion of the morning session was devoted to the usual routine business. Papers were presented by J. C. Hancock on the Risk of a Single Supply Main ; by S. E. Babcock, on Water Pipe Joints ; by George F. Chase, on Direct Pumping Systems.

Afternoon and evening sessions were also held on this day, the afternoon session being devoted to the reading of papers, including one on the New Haven Water Company's Dam, by L. A. Taylor ; one on Dangers through Tunnel or Low Grade Aqueducts, by D. FitzGerald, and one on Studies on Algæ and Infusoria in Water, by F. F. Forbes.

The evening session was devoted to discussion of topics suggested. Among those presented at the Convention were Minimum Size of Mains; Water Meters; House Inspection; Ordinary and Fire Supply for Factories; Service Pipes, and Reasons why a Hydrant does not deliver full supply.

The third day was principally given up to a visit to the reservoirs of the Hartford Water-Works under the escort of the Water Commissioners of the City. In the afternoon the convention adjourned, after an unusually successful meeting.

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**American Boiler Manufacturers' Association.** The annual meeting of this Association was held in St. Louis, May 12, 13, and 14, and some important discussions were had. Reports were submitted by the Committees on Material and Tests, on Boiler Tubes, on Man-holes and on State Inspection Laws. The rules governing inspection by the United States were also discussed and a form of bill drawn up and presented.

The officers elected for the ensuing year are: President, James Lappan, Pittsburgh, Pa.; First Vice-President, Philip Rohan, St. Louis; Second Vice-President, James Kenney, St. Paul; Third Vice-President, Charles Kroeshell, Chicago; Secretary, E. D. Meier, St. Louis; Treasurer, Richard Hammond, Buffalo, N. Y.

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**American Society of Civil Engineers.**—The Annual Convention began, according to programme, at Chattanooga, Tenn., May 21, and continued until May 26, with a very large attendance of members. The feature of the meeting was the annual address of President Chanute, which referred at considerable length to the important engineering works of the year, including tunnels, ship canals, bridges and other works. Mr. Chanute also referred at considerable length to the future of the Society and spoke of the best method of increasing interest in the same.

Among the more important papers read was one by Mr. John E. Greiner on the American Railroad Viaduct; one by W. B. Parsons on Mountain Railroad Construction; one by R. W. Griffin on Car-Wheels. A number of other papers of interest were also presented and discussed.

There was a lively discussion on the appointment of a nominating committee and upon the method of nominating officers of the Society. A number of candidates were presented, and will be voted upon by letter ballot.

During the continuance of the meeting the members visited numerous points of interest in Chattanooga and vicinity. The annual banquet of the Society was held on the evening of May 24, about 100 members being present with a number of guests, including ladies.

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**American Institute of Mining Engineers.**—The summer meeting was held in Cleveland, O., beginning Tuesday, June 2. Business sessions were held on Tuesday, Wednesday, Thursday, and Friday. Wednesday and Thursday were largely given up to visits to local works, and Friday afternoon was devoted to an inspection of the ore docks, shipyards and water works of Cleveland. The annual dinner was held in the evening of Thursday, and was largely attended.

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**American Society of Mechanical Engineers.**—The last social gathering for the season was held at the club house in New York, May 28. A portrait of Mr. Henry R. Worthington was presented to the Society. Dr. R. W. Raymond made an address on Egypt, giving some notes gathered by him while on a visit to that country last winter.

These social gatherings have been a feature much enjoyed by resident and visiting members, and will be continued next winter.

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**Technical Society of the Pacific Coast.**—At the regular May meeting in San Francisco, Mr. R. Hinchcliffe read a paper on the Hall Hydro-Steam Elevator.

Mr. Gutzkow exhibited an induction pump for raising liquids. Mr. W. N. Anderson exhibited a device for working elevator doors automatically.

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**Western Railway Club.**—At the May meeting in Chicago, there was a discussion on the subject of Air-Brakes of Interchange Cars, in which many members joined and a set of rules was adopted for submission to the Master Car Builders' Association.

Professor W. F. Johnson read a paper on Steam Heating, which was discussed.

Mr. Barr read a note about Bending Steel at different temperatures.

The meeting was closed by a short discussion on Joint Inspection of Cars.

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**Engineers' Society of St. Louis.**—At the regular meeting in St. Louis, May 20, Messrs. B. E. Chollar and E. A. Herman were chosen members.

Mr. Carl Gayler then read a paper on Viaducts Across the Railroad Track in St. Louis, describing some of the difficulties encountered with bridges over the tracks in that city, and some of the accidents which had occurred. In conclusion he offered some suggestions as a result of the experience obtained with existing bridges. This paper was generally discussed by members present.

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At the regular meeting, June 3, R. E. McMath was chosen Librarian. A committee was appointed to revise the Constitution.

Dr. Wellington Adams read a paper on Mechanical Propulsion of Road Carriages, in which he advocated the use of a high-speed rotary steam-engine with steam produced by burning oil. This paper was pretty sharply discussed by members present.

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**Wisconsin Polytechnic Society.**—This Society was organized in November last at Milwaukee, and was incorporated in March of this year. It has a considerable membership and holds regular meetings on the second Monday in each month.

## NOTES AND NEWS.

**Bids for New Lightships.**—The Lighthouse Board has been receiving bids for four new lightships, to be known as Nos. 51, 52, 53 and 54, and to be stationed respectively at Cornfield Point, Long Island Sound; Fenwick Island Shoal, off the New Jersey coast; Frying Pan Shoal, off the North Carolina coast, and Martin's Industry, off the Georgia coast.

These lightships will be far superior to any heretofore built and will embody many novel ideas, the most important of which is giving them propellers and steam-engines, so that they will not be entirely at the mercy of the sea. They can steam out to their stations without assistance, and in many storms, when they would be blown from their anchorage, they can ease the strain on their anchor chains by steaming against the storm. Then, if cast adrift, they will not be helpless, but can make the nearest port. Their steam outfit will include a steam windlass and a small engine for working the steam fog signal.

The general dimensions of the ships will be: Length over all, 118 ft. 10 in.; beam, 26 ft. 6 in.; depth of hold, 14 ft. 6 in. They will be built of iron and steel, and the hulls will be subdivided by four main bulkheads, extending up to the main deck. Bilge keels 55 ft. in length will be worked on each side of the vessels, and will help to steady them in rough weather. Another novelty that will contribute to the steadiness of the vessels is the arrangement of the hawse-pipes, which will pass directly through the stern-posts of the vessels, instead of at one side, so that they will pull more evenly on their cables. The vessels will be rigged with two masts and try-sail masts.

The Cornfield Point vessel will be provided with flash electric lights, four of them being carried in lense lanterns at each masthead. Each of these separate lights will be about equal to the ordinary sixth-order light. The electric plants will be in duplicate throughout. The Lighthouse Board is now experimenting at Staten Island with revolving screens for light-vessel lights, and it is probable that, when these vessels are completed, Nos. 52, 53 and 54 will also have lights with distinctive characteristics. The vessels are to be completed within ten months from the date of contract.

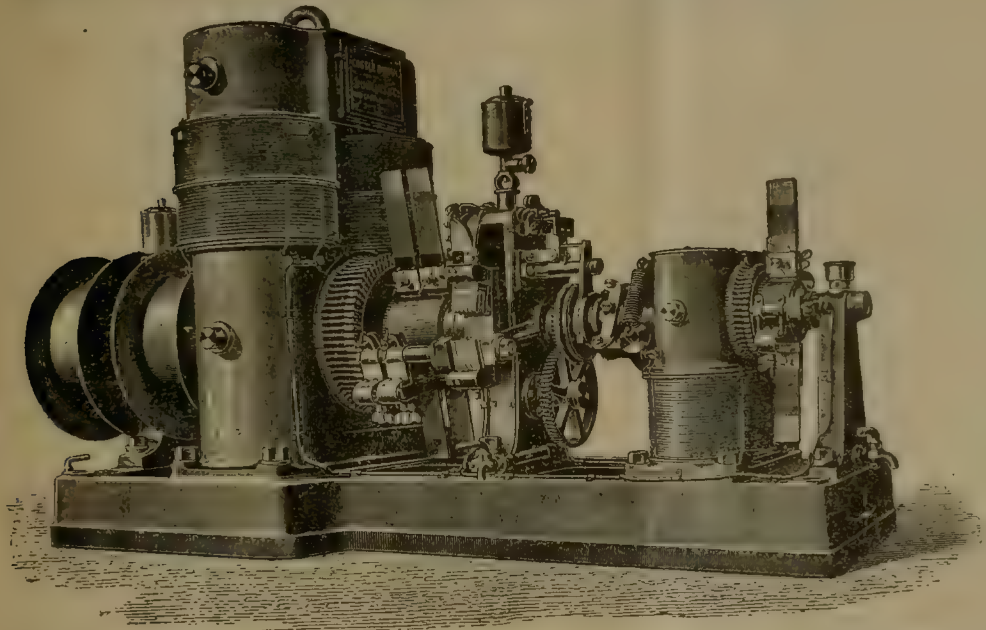
**Roads and Vehicles.**—In a paper recently read before the Engineering Association of the South, Mr. J. M. Heiskell presented the argument that economy of street and highway traffic could best be secured by paying attention to improving the vehicle rather than the road surface, and to accomplish this recommended strongly the introduction by proper legislation of the following features in the construction of vehicles: 1. Width of tire to be dependent on weight of load. 2. Length of axle to be dependent on weight of load in order to insure non-tracking of vehicles. 3. A difference of length between front and rear axle to insure non-tracking between front and rear wheels. 4. The introduction of springs for heavy draft wagons. The paper presented estimates based on quotations from paving companies, giving their prices for guaranteeing the maintenance of their pavements for terms of years under existing circumstances and also under conditions to be secured by legislation requiring the above improvements in vehicles.

**Dynamos for Train Lighting.**—In England and in France, where more progress has been made in the use of electricity for lighting trains than in this country, the chief difficulty found has been the variation of speed in driving the dynamos. Separate engines have been used and have been found not altogether satisfactory. The accompanying illustration and description, which are taken from our excellent contemporary, *Industries*, shows a solution devised by J. H. Holmes, of Newcastle-on-Tyne, England. This dynamo has been used with much success on the Midland Railway in England, the Northern Railroad in France, and on some lines in Germany and in Russia, and has, it is claimed, passed beyond the stage of experiment. The inventor explains his device as follows :

Practically, the e.m.f. of an ordinary separately excited dynamo varies directly as the speed, so if the speed be increased, say, from 500 revolutions per minute to 1,000 revolutions per minute, the electro-motive force will be doubled. The electro-motive force varies directly as the strength of the magnetic field, so that, if the strength of field of a separately excited dynamo be reduced in the same proportion as the speed at which its armature revolves be increased, the electro-motive force of the armature will remain practically constant.

To produce this result two dynamos are arranged having their armatures upon the same shaft, so as to revolve together, but influenced by separate magnetic fields. One is the main generating machine, the other is for regulating the strength of its magnetic field. The magnets of the machines are separately excited from an external source, such as a set of accumulators, and the magnets of the generating armature are provided with two distinct exciting circuits. One circuit is an ordinary high-resistance shunt circuit, and the other is of less resistance, and is coupled up to the source of current so as to have the small regulating armature in series with it. The regulating armature is so coupled up that its electromotive force opposes the electromotive force of the regulating armature and external source of supply. The high-resistance shunt circuit is so proportioned that, at the highest speed at which it is intended to run the generating armature, it, without the aid of the regulating circuit, will give a magnetic field of an intensity proper for the required e.m.f. in the generating armature. When thus driven the second exciting circuit ought to have no current passing through it, and this is secured by making the e.m.f. of the regulating armature at its highest speed equal and opposite to the external source of e.m.f. produced in the second coil of the generating machine. If, however, the speed falls, the e.m.f. of the regulating armature is reduced in the same proportion, and is no longer equal to the external e.m.f., and a current will flow through the second exciting circuit of the magnets of the generating dynamo, thus increasing the intensity of the magnetic field to make up for reduction of speed, maintaining a practically uniform e.m.f.

The armature is driven by belting from the axle of the guard's van, and a set of accumulators excite the field magnets. A centrifugal governor automatically switches the storage batteries in or out. The brushes which collect the current from the two armatures are made of wire gauze, and are placed radially, the "lead" being automatically altered to suit the direction of rotation. The connections to the armatures are changed at the same time.



It may be noted here that, in a paper recently read before the Royal Society in London, it was stated that the cost of fitting a car for electric lighting on the Midland Railway was about $240, while the special van or car carrying the dynamo cost from $1,200 to $1,400. The actual running cost for electricity as used on the Midland Railroad was about 0.5 cent per lamp per hour, being a little over one-half the cost with compressed gas.

**An Ingenious Arrangement of Power.**—At the new works of the Newport News Shipbuilding & Dry Dock Company at Newport News, Va., the various shops are necessarily separated from each other, and the primary engineering conditions are such as to demand the subdivision of power almost as a necessity. The key to the successful subdivision of power was found in the use of a type of engine, whose specific economy in moderate sizes should be as good, or better, than that of a single large central engine ; and further, in the use of some practical device for preventing the dangerous accumulation of water in an extended system of piping, and for returning all condensation to the boilers as a measure of economy. This contract, comprising engines and steam-loops, was awarded to Westinghouse, Church, Kerr & Company, and comprises, up to date, seven independent Westinghouse compound engines, as follows : One of 80 H. P., one of 130 H. P., four of 200 H. P. each, and one of 330 H. P., each protected by a separator and steam-loop. A central boiler plant of high-pressure boilers supplies steam to these engines, most of which are several hundred feet distant, and also to sundry pumps and other steam machinery. The steam mains, which commence with a diameter of 14 in., are laid in an interesting and original manner. To go overhead was out of the question, and the problem of an underground line was a difficult one, on account of the nature of the ground, which, for the most part, is soft silt, flooded at high tide. A subway was therefore constructed by sinking a large steel tube of sufficient diameter to carry all the steam and water pipes with the steam-loop returns, and allowing ample head room for inspection. Y branches and eccentric reducers are freely used, and expansion is taken care of by copper bends at the angles. The steel subway itself is used as a hot-air duct, distributing from an indirect system with fan-blast for heating the various buildings. High-pressure steam at about 150 lbs. is carried through the entire system. The return system at present consists of 6 separators and 13 steam-loops, all entering into one common 4-in. return, which lies parallel to the steam pipe in the steel tunnel above described.

**Lead Pipe Bored by a Worm.**—In a note recently published in the German *Sanitary Engineer*, Herr K. Hartmann gives an instance of a lead pipe pierced by a larva of the wood wasp, the insect being actually found with its head in the hole pierced by it. A workman employed by the firm of Naruhn & Petsch was called in to repair a defective pipe which had been injured on a previous occasion, as was reported, by a "nail-hole" occurring in a soldered joint. This time the worm causing the mischief was found in place. The hole on the exterior of the pipe was of a rounded form, 7 millimeters long by 4 mm. wide, and the penetration was through the entire thickness of the metal. By quotations from various publications it is shown that, though of rare occurrence, well-authenticated instances of similar injuries by insects are on record.

**A New Gold-Colored Alloy.**—Herr T. Held has invented an alloy of copper and antimony in the proportion of 100 to 6 which is made by melting the copper, and when at the right heat adding the antimony ; and when both are melted and intimately mixed, fluxing the mass in the crucible, with an addition of wood-ashes, magnesium and carbonate of lime, which has the

effect of removing porosity and increasing the density of the metal when cast. The alloy can be rolled, forged and soldered in the same manner as gold, which it very closely resembles when polished, the gold color being unchanged, even after long exposure to ammonia and acid vapors in the atmosphere. It is also much stronger than gold. The cost of the alloy in the ingot is about 25 cents a pound.—*Dingler's Polytechnische Journal.*

**Copper Production of the World.**—The following figures, compiled in Paris and published in the *Revue Scientifique*, give the copper production of the world for 12 years past. The several columns show the total output, and that of the three more important copper-producing countries:

| YEAR. | Total Product. | United States. | Chili. | Spain and Portugal. |
|---|---|---|---|---|
| | *Tons.* | *Tons.* | *Tons.* | *Tons.* |
| 1879 | 151,963 | 23,350 | 49,318 | 33,361 |
| 1880 | 153,959 | 25,010 | 42,916 | 36,313 |
| 1881 | 163,369 | 30,882 | 37,989 | 39,258 |
| 1882 | 181,622 | 40,470 | 42,909 | 39,560 |
| 1883 | 199,406 | 51,570 | 41,099 | 44,607 |
| 1884 | 220,249 | 64,700 | 41,648 | 46,415 |
| 1885 | 225,592 | 74,050 | 38,500 | 47,873 |
| 1886 | 217,086 | 69,805 | 35,025 | 49,653 |
| 1887 | 223,078 | 79,109 | 29,150 | 53,706 |
| 1888 | 258,026 | 101,710 | 31,240 | 56,450 |
| 1889 | 261,650 | 105,774 | 24,250 | 54,800 |
| 1890 | 269,685 | 116,325 | 26,120 | 52,333 |

With the exception of two years the total output has shown a steady growth, and that of 1890 shows an increase of 77½ per cent. over 1879. The product of the Spanish and Portuguese mines has shown a steady increase, but has not quite kept up with the total, that of 1890 showing a gain of 56⅞ per cent. only over 1879. The Chilian production has varied considerably, but in the opposite direction, 1890 exhibiting a loss of 47 per cent. from 1879. In the smaller copper-producing countries the industry has advanced; taken together their output in 1890 increased 62⅔ per cent. over 1879.

The great increase has been in the United States, which, with the exception of one year, has shown a large and constant growth in this respect. So great has this been that the output of 1890 shows a gain of 398 per cent. over that of 1879. This gain is further shown by the fact that in 1879 the United States furnished 15 per cent. of the total supply of the world; in 1883, it supplied 26; in 1887, it had 35½; and in 1890 no less than 43 per cent. Those years are taken periodically, and not on account of any exceptional production.

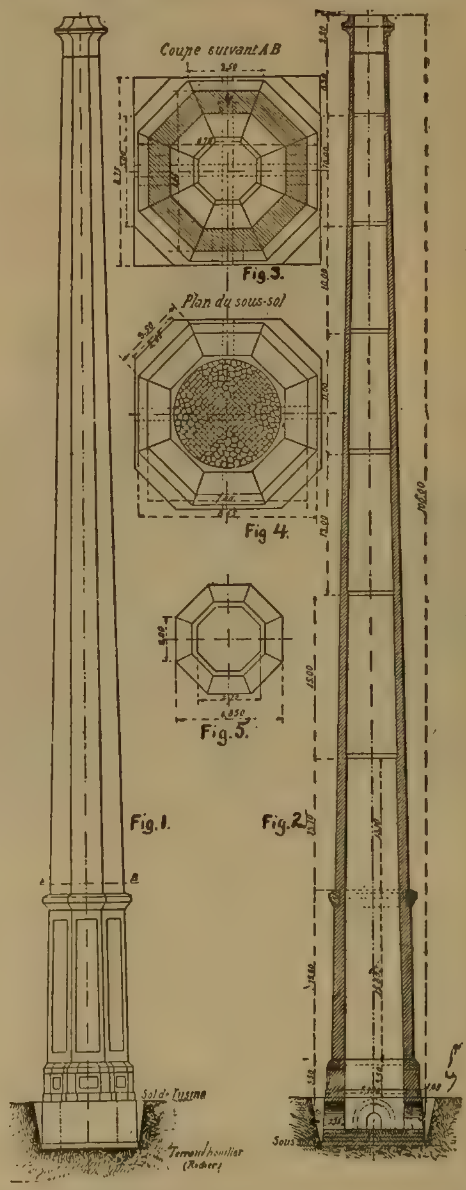
The consumption of copper has increased in about the same degree as the production; and the surplus stocks are not now proportionally greater than they were 12 years ago.

**London-Paris Telephone.**—Since March last a telephone line has been in regular operation between London and Paris. A special cable was laid under the English Channel for this line, which consists of the land line from Paris to Saugatte, near Calais, about 200 miles; the cable, 26½ miles, and the land line from St. Margaret Bay, near Dover, to London, about 50 miles. Between the central stations in London and Paris conversation is easily carried on, the line working very well; but some trouble has been found in the connections with the local city circuits, and there are no private telephones connected as yet.

The tariff is high, the charge being 10 francs in Paris or 8 shillings in London—nearly $2—for the use of the line for a "period;" the time of the period has been fixed at three minutes only.

**Water Power and Electric Transmission.**—The Cœur d'Alene Company, of Idaho, have under construction a power plant, which considering its extent and the variety of work to be operated, will be one of the most important installations of a mining character yet made. The plant is located on Cañon Creek, about 1½ miles from the mill and mine of the company, and consist of two 225 H. P. Edison generators driven by Pelton wheels running under 690 ft. head. The mill machinery will be driven by an 80 H. P. motor connected direct to the main shaft. The compressor will be driven by a 60 H. P. wheel connected to the fly-wheel. The hoisting machinery will also be run by a 60 H. P. Pelton wheel geared direct to present driving shaft. The pump situated on the 500-ft. level will be driven by an 80 H. P. Pelton wheel directly geared. The entire plant has been planned to connect with the machinery already in use and now operated by steam. It is expected that the operating expenses of the company will be reduced fully 50 per cent., when the new power station is in running order. —*Industry, San Francisco.*

**A Tall Chimney.**—The accompanying illustrations, from *Le Genie Civil*, show one of the tallest chimneys in the world, its height being exceeded only by six others now in existence. It is a central chimney provided for the forges at the Naval Steel Works, at St. Chamond, France. This chimney has the advantage of being founded upon a rocky base which is there found at only a short distance below the surface. Its height above the surface of the ground is 100 m. (328 ft.). The general design and the division into sections are shown in the illustrations in which the dimensions are given in meters. Fig. 1 is an




elevation; fig. 2 a section; fig. 3 a cross-section on the line *A B*, fig. 1; fig. 4 is a plan of the foundation, and fig. 5 a plan of the top or coping. Figs. 3, 4 and 5 are on a larger scale than figs. 1 and 2. The chimney is octagonal in shape, as shown in the drawings. The general dimensions are as follows: Height from the surface of the ground 100 m. (328 ft.); exterior diameter at the base 7.40 m. (24.27 ft.); at the summit 3.25 m. (10.66 ft.); interior diameter at the base 5.15 m. (16.89 ft.); at the summit 2.70 m. (8.86 ft.); thickness of wall at the base 1.125 m. (3.69 ft.); at the summit 0.325 m. (1.06 ft.). The ratio of the diameter to the height is 1 to 135. The calculated stability for the highest wind pressure which can be expected in that region is 2.20, the normal stability just sufficient to resist the wind being assumed at 1. This chimney has been built with great care as to material and construction, and is certainly very graceful in its proportions.

THE RAILROAD AND

# ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

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NEW YORK, AUGUST, 1891.

THE Council of the Royal Society of Arts has been constituted a Commission by the British Government to represent it and to look after the interests of British exhibitors at the Columbian Exhibition in Chicago. The Prince of Wales is Honorary President of this Commission; its Chairman is Sir Richard Webster, and its Secretary Sir Henry Wood. There are 36 members, prominent among whom are Mr. James Dredge, Editor of *Engineering*, and Sir Philip Cunliffe Owen, both well known in the United States.

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THE Massachusetts Company of the Naval Reserve or militia had a term of practical drill during the visit of the Squadron of Evolution to Boston in July. The men were exercised on board ship and at the guns, receiving a short but strict tour of instruction.

The New York Naval Militia has been completely organized. As mustered into the State service, the battalion numbered 201 men, under command of Lieutenant-Commander Jacob W. Miller, Lieutenants S. D. Greene, W. B. Duncan, Jr., L. Mowbray, and L. M. Forshew. A period of sea drill was had on the squadron evolution, in the third week in July.

A battalion of naval militia will probably be organized at Norfolk, Va. A movement for enlistment has been started there and is in excellent hands. Norfolk presents many advantages as headquarters of a battalion.

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SOME additional trials have lately been made at Annapolis with comparatively light plates treated by the Harvey process. These plates are of 3-in. steel; the gun used was a 6-pdr. Hotchkiss cannon, using forged steel projectiles, and giving an initial velocity of about 1,800 ft. The results have been very favorable, the plates resisting successfully all the shots fired.

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AN interesting competitive test of heavy rapid-fire guns will soon be begun at the Army proving grounds at Sandy Hook, New York Bay. Three guns have been entered for this test, one American, the Hotchkiss 4.7-in. gun; one French, the Canet 15-cm. (5.9-in.), and one English, the Armstrong 4.72-in. These are the heaviest rapid-fire guns yet brought forward, with the exception of the Armstrong 6-in. gun, which has lately been tried in England. The Hotchkiss and the Armstrong guns at Sandy Hook are practically of the same caliber, and their projectiles are also nearly of the same weight, about 60 lbs. The Canet gun is over an inch larger in caliber, but the weight of its shot is not very much greater. The Hotchkiss and the Canet guns will use French smokeless powder; the Armstrong gun cordite powder. The tests will include both rapidity and accuracy of fire, and also the resistance of the guns to continued use.

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THE great 125-ton steam hammer at the Bethlehem Iron Works—the largest in the world—has been completed, and has begun its work of making heavy forgings for guns and armor plates. The size of this hammer may be estimated from a few figures. The pit for the foundation was 58 × 62 ft., and the foundation walls are 30 ft. in height. The anvil, which is entirely distinct from the hammer, is built up on a foundation of stone and timber, and has some 1,800 tons of iron in it. The top of the hammer is 90 ft. above the floor of the shop; the steam cylinder is 6 ft. 4 in. in diameter and 16 ft. 6 in. stroke. The piston-rod is of steel and is 16 in. in diameter and 40 ft. long. The hammer-head is of cast iron, the block being 19½ × 10 × 4 ft., and the die or hammer face is of steel. The weight of the working parts, by which the hammer is rated, is 125 tons altogether, and the full force of the blow given by this weight of metal falling 16½ ft. may be estimated.

The hammer stands in a building erected purposely to hold it, and is provided with cranes and other appliances for handling the enormous ingots which will be forged into shape under it. The Bethlehem Company has certainly shown great enterprise in undertaking the establishment of the great plant for armor and gun forgings, which it has now nearly completed.

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THE Postmaster-General has issued the advertisements of mail lettings for ocean service under the Postal Aid Bill passed by the last Congress. The advertisements call for bids for mail service in American built ships from a number of ports, the chief lines named being from New York, Boston, and Baltimore to European ports; from New York and Philadelphia to Buenos Ayres; from Baltimore and Norfolk to Brazilian and West Indian ports; from Port Tampa to La Guayra and Santos; from New Orleans and Galveston to Colon; from New York to San Francisco *via* Panama; from San Francisco to South American ports, to China, Japan, Australia, and New Zealand; from New Orleans to the principal ports on the Spanish Main; a number of lesser routes are also included.

A number of the lines advertised are already in existence, but a number proposed are entirely new. The law provides a rate of $4 per mile for first-class service—that is, in 20-knot steamers of not less than 8,000 tons; for second-class service—in 16-knot ships of 5,000 tons or over—$2 per mile; for third-class—14-knot vessels of 2,500 tons or over—$1 per mile; and for fourth-class—12-knot ships of 1,500 tons—66⅔ cents per mile.

To meet the first-class standard, a number of new vessels will have to be built, and three years' time will be allowed to fill the conditions. Vessels approved for mail service under this law must be owned and built in this country, must be officered by American citizens, and must be adapted for use as cruisers in case of war, in the higher classes; the lower classes of ships not fitted for cruisers to be subject to use as transports, if needed.

Contracts are to be made for 10 years, and the date for opening bids is October 26 next.

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THE formation of a lake of considerable extent though of no very great depth is reported in the Colorado Desert, the nearest point of settlement being Salton Station, on the Southern Pacific Railroad. The lake has grown gradually and steadily for some time, but no damage has been done, as the country is entirely without settlers. It has its origin in an overflow of the Colorado River into the great desert basin, most of which is considerably below the level of the sea, and which was undoubtedly at one time connected with the Gulf of California.

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## ENGLISH AND AMERICAN LOCOMOTIVES.

IT should be mentioned at the beginning of this article, that it is merely a sort of reconnoissance of the position of the *Engineer* on this subject. Several months ago we promised our readers and our contemporary that we would collect and publish some statistics relating to the performance of American locomotives. As was intimated at that time, data which will enable us to make comparisons of the performance of American locomotives with that of their English contemporaries, which will have any value, are not easy to obtain. Many of our railroad companies do not keep any account of the consumption of fuel of their locomotives, and some of those which do give no reports of loads hauled. Besides this difficulty, the forms and methods of keeping these reports vary a great deal on different roads. From some of them we have received most elaborate reports, printed on several large sheets 19 × 36 in. in size, on which statistical information is given in the utmost detail. Other reports are printed on the back of a postal-card, and consequently the information given is very meager. Even when the records contain data which is needed it must usually be carefully analyzed and tabulated before any comparisons can be made or reliable conclusions drawn therefrom.

To be able to compare the performance of locomotives here and in a foreign country, it seems to be essential to know:

1st. The average number of miles which such machines run in a given time here and there.

2d. The average loads hauled.

3d. The amount of fuel consumed per mile run.

4th. The cost of repairs per mile run.

5th. The other running expenses, including oil and waste, wages of locomotive runners and firemen, cleaning engines, etc.

While this information cannot be obtained from all our companies, yet many of them can furnish such data, and, from what we regard as reliable sources, we have collected the items of information referred to above concerning the performance of from 7,000 to 10,000 locomotives in different parts of this country.

In the *Engineer* of November 7 of last year an elaborate table was published in which information was given with reference to the mileage, fuel consumption, cost of repairs and "cost of working" of locomotives in the United Kingdom. It was not stated what was included under the head of "cost of working," and the train loads were not given, although the traffic receipts per train mile were. Therein lies our difficulty, and we ask the aid of our contemporary to help us out of it. If there is any way of ascertaining the average weight of the trains hauled by British engines, it would make it possible to compare the performance of locomotives here and there. Without such information it is not comparable.

In a report made to the British Board of Trade in 1887 it is said that "passenger mileage and ton mileage are not required to be shown in the returns annually made by the companies under Act of Parliament." As we have not been able to find such data in any of the Board of Trade or other reports to Parliament which are accessible to us, we infer that such statistics are not kept, or are not published by English railway companies. In the absence of such data the average train loads could be calculated approximately from the traffic receipts if the average rates per ton per mile for carrying goods was known. Although it may not be possible to ascertain what the average rate is, it should be practicable to fix some maximum and minimum limits for the average rates. In a "Return" by the Railway Companies in the United Kingdom to the House of Commons showing the Rates charged for the carriage of various articles, dated February 1, 1887, we find very few rates less than a penny a mile, and nearly all are more—some of them very much more. Our inference is that 1*d.* per ton per mile would be a very low estimate of the average railway rate for carrying goods on British roads. As the average traffic receipts per goods train mile is given by the *Engineer* as 5*s.* 10.08*d.* on all the roads of the United Kingdom, if the average rate is not less than 1*d.* per ton per mile the average paying load cannot exceed 70.08 tons. If the dead-weight of the cars or wagons is equal to the paying load, the average weight of the trains exclusive of the engine and tender would not exceed 140.16 tons. If the dead-weight is twice the paying load, the trains would weigh 210.24 tons, but would not exceed that amount. Can the *Engineer* throw any light on this?

In a recent review of "The Railways and the Traders; a Sketch of the Railway Rates Question in Theory and Practice," by W. M. Acworth, it is said that "in this country" (presumably Great Britain) "300,000,000 tons were carried in 1889 for £40,000,000 sterling, or at an average cost of 2*s.* 8*d.* per ton." There is no means of arriving at the average distance each ton was carried. Mr. Acworth (Chapter IX.) puts it at 25½ miles, which brings the cost to 1¼*d.* per mile.

It ought to be possible to know with more or less definiteness whether the average rate for carrying goods in the United Kingdom is less than a penny per ton per mile, or more than twopence. Is the average rate less than a penny per mile or more than twopence, and is the dead-weight of cars on British roads more or less than the paying weight of goods, and what expenses are included under "cost of working"? The *Engineer* must have sources of information with reference to these points which are not accessible to us, and if these questions were answered it

would help very much to clarify the discussion of this subject, which, it must be admitted, has at times been somewhat turbid.

## THE DANGER FROM LOCOMOTIVE CHECK-VALVES.

ONE of the most horrible in all the dreadful record of railroad accidents occurred on the Colorado Midland Railroad, at Aspen Junction, Col., on July 11. The daily papers publish the following report of it :

A party of Midland officials have made a preliminary investigation of the accident and its causes. Their report of the affair differs materially from that first given out. It is as follows :

A freight-train was standing on a side-track alongside the main ready to be pulled out by Engineer Sheperd with the engine which was coming out of the roundhouse. The switchman had thrown the switch for the light engine when he noticed the excursion train backing down from the tank. He immediately signaled both trains to stop, which they did. He then signaled the light engine to back up, and the brakeman on the rear end of the passenger train, which had been backing up, also took the order. The result was a "cornering" of the coach and the engine at the switch, the window of the compartment coach taking off the check-valve as before stated. The light engine immediately stopped, and the opening in the boiler made by the loss of the valve being directly opposite an open window in the compartment of the coach which contained all the passengers except the three colored men, belched forth its awful death-dealing vapor. All the other windows and doors of the car were closed, hence the compartment took on the nature of a steam chest. The pressure of the steam in the close compartment was so great that when a door was finally knocked open from without, the liberated steam threw the rescuer violently on his back. The nature of the accident is such that it is a wonder that any of the occupants of the coach are living. Joseph Leonard's flesh was so thoroughly parboiled that when he attempted to knock out a window with his hand his flesh stuck to the glass.

On the 13th it was announced that the eighth victim had died, and that four others cannot survive. A faint idea may be formed of the inexpressible and inconceivable horror of this accident on reading that one of the victims had not a particle of skin on her hips, and of another that the skin was almost entirely scalded from his face and shoulders.

Accidents of this kind have occurred before. It will be remembered by some of our readers that in 1880, in a collision on the Pennsylvania Railroad, just east of Pittsburgh, a large number of people were scalded to death from exactly the same cause. A local train was standing at a station and a following train ran into it. The colliding engine telescoped the rear car of the front train, and in doing so knocked off the check-valve case, and the hot water and steam were discharged from the boiler into a crowded car. The scalding of passengers in the May's Landing accident on the West Jersey & Atlantic Railroad, also in 1880, was probably due to the same cause. On the Cincinnati, Hamilton & Dayton road another accident occurred, in 1880, in which a number of people were scalded, but it was owing to a blower-cock being broken off.

If such occurrences could not be prevented they would be the occasion for the exercise only of fortitude and resignation on the part of the sufferers and their friends, and of sympathy by those who contemplate the affliction of the victims. But if they can be prevented they should be a powerful stimulus to every railroad officer in the land to seek for remedies which will prevent similar disasters in future. There is no excuse either for the non-exercise of vigilance and energy for the prevention of this class of accidents, because preventative means are within easy reach. As the danger is due to the exposed position of the check-valves, the thing to do is to remove them to safer positions. This can readily be done by placing the injectors and the check-valves on the back end of the boiler, and running the feed-pipes to the front end of the tubes inside—instead of outside—of the boiler. This is a general practice in England, and also on the Canadian Pacific Railroad, of which an illustration was published in the JOURNAL of August, 1888, and may be found in the new edition of the Catechism of the Locomotive, page 235.

Another method is the use of a safety check-valve ; that is, one with the valve inside the boiler, so that if the case or pipe outside is broken off, the valve inside will close and prevent the escape of steam or hot water. A device of this kind was illustrated in the JOURNAL last month, and another, also illustrated and described in the new edition of the Catechism of the Locomotive, is the invention of Mr. Hayward, Superintendent of Machinery of the Pennsylvania Railroad, at Jersey City, and is in use on that line. Any of these would have prevented the lamentable accident which occurred at Aspen Junction a short time ago, and that which happened near Pittsburgh in 1880, and if adopted now would doubtless prevent other equally dreadful calamities in the future. It is to be feared, though, that unless legislative pressure is exerted on them, the railroad companies will not show great alacrity in adopting such safeguards. The danger seems remote, and accidents of this kind are not very frequent, and are rarely or never repeated in the same place. The dreadful lessons which they teach are soon forgotten, and are seldom or never repeated to the same people. Indifference is so easy, and vigilance so difficult, and habit so hard to uproot. Railroad Commissions are, however, created for the purpose of stimulating the lagging efforts of railroad companies in just such directions as this. The subject is respectfully called to their attention. A circular from these officials to the managers of railroads, asking what measures have been taken to guard against such accidents as that which occurred at Aspen Junction, would compel the managers to give the subject sufficient thought to answer the inquiry, and that would be a step gained. As such accidents can easily be prevented, with little expense to railroad companies, at least all new locomotives which are built hereafter should have adequate safeguards for the prevention of such calamities in future.

## NEW PUBLICATIONS.

PANTOBIBLION. *International Bibliographical Review of the World's Scientific Literature.* Edited by A. Kersha, C.E. St. Petersburg, Russia.

This is the first number of a monthly publication, the object of which is to help technical and scientific students by keeping them informed as to all the literature of interest to them which may be published from time to time. It will aim to present a classified list of all new books issued in civilized countries on scientific subjects ; critical notices of all the more important works which may appear from time to time ; a review of current periodical literature, and finally brief notes on scientific topics.

The Editor has thus laid down a sufficiently ambitious programme, and to carry it out will require hard and constant work. To follow up the periodicals alone, one would suppose, would be a sufficiently serious task. For the first number some shortcomings are admitted, chiefly due, it is said, to the failure of publishers to respond promptly to requests for information, and it would not be fair to criticise the opening number too closely.

For European publications and periodicals M. Kersha has

done very well, but his American list is very defective. This, however, may be remedied in future numbers.

The classification and arrangement are good, and a regular reader will soon learn to turn at once to the subject which interests him. The remarks on each book or journal and the criticisms of those books which are noticed are given in the language in which the book itself is printed, so that a page of French may be followed by one of German, that again by one of English or Spanish, and one must be a linguist of some ability to read steadily. The book, however, may be of considerable value to students and readers.

THE OFFICIAL RAILWAY LIST. *A Handbook of Useful Information for Railway Men. Tenth Year*, 1891. Walter D. Crosman, Editor. (Chicago; the Railway Purchasing Agent Company, No. 816, the Rookery.)

This is the tenth number of a very useful work. It is a directory of railroad officers in the United States, including not only the general officers, but also those of the operating, traffic, maintenance of way, motive power, and car departments. The value of such a book is, of course, in its reliability; and long experience with the *Official List* as a desk companion has proved that the editor and publisher take much pains with their work, and that the yearly volumes are kept well corrected up to the date of their publication.

The book may be said to serve also as a directory of dealers in and manufacturers of railroad supplies, since those classes of business men have become so accustomed to advertising in its yearly issues that the list of those who are absent is not a long one.

RETAINING WALLS FOR EARTH. *Including the Theory of Earth-Pressure as Developed from the Ellipse of Stress.* By Malverd A. Howe, Professor of Civil Engineering, Rose Polytechnic Institute. (John Wiley & Sons, New York; price, $1.25.)

This is the second edition of Professor Howe's book, the first having come already to be considered a standard work. The first edition was based upon the theory of Weyrauch, but in the present one new and shorter demonstrations have been presented. These give the same results, but are, it is believed, more direct and simple. To permit comparisons, however, Weyrauch's demonstrations are given in an appendix.

An addition made in the present edition is a chapter on the supporting power of earth in the case of foundations; another is a formula for determining the breadth of the base of a retaining wall. Both of these will be useful to engineers in many cases.

Professor Howe has treated his subject as briefly as possible, giving the formulas first in a condensed form by themselves, and then following with examples illustrating their application. Tables of strength and weight of various kinds of stone, of co-efficients of friction, and of other co-efficients used in the formulas are appended.

The book is a useful one both for students and for engineers in practice, and requires little criticism. The diagrams and illustrations are generally good, although some of them would have been clearer had they been made on a larger scale.

COMBUSTION IN THE FIRE-BOX. By Ira D. Stocking, Troy, Kansas.

This is a small pamphlet of eight pages, of which the author says, " you will see some ideas that has never been advansed, if so I never have sene them. in the artickle I no doubt have used the Languge of others in expressing myself, but could it be otherwise, as we all must Learn from others."

A few quotations will give an idea of the character of this "artickle." The author says:

As all subjects must have a foundation, or a starting point, for the benefit of listeners who are supposed to be students on this occasion, our first lesson will be in the elementary department of chemistry, its action in the fire-box to assist in the producing of steam and to make a beginning of this subject we must understand some of Nature's laws, which is both proper and right. If it is no crime to understand the chemical properties of the vegetables we eat, what can be the objections of understanding the chemical properties of the atmosphere we breathe.

But science has scarcely reached the primary department of this, as well as numerous other subjects and consequently it cannot be expected.

Fathom only the shoals of such a boundless problem. But science, in its infancy, is driving before it the fog of prejudice and superstition from the fields of thought and securing to itself the right to explore, without limit to its boundless magnitude.

And now I will return to my subject again. Air and atmosphere is the two first principles in Nature, but are two distinct elements, but their relations are such, in the developing of Nature, as to be indispensable to each other, as it cannot act as an invigorator in the developing of vegetable or animal life for want of the vital fluids and gasses, but when combined readily fill all these requirements. Air in its original condition is not transparent, as is the general supposition, as it is void of a prismatic vapor. But before further proceedure with this subject I shall be obliged to use the term compound a great many times, it may be well enough to give its meaning a little attention, what is meant by a compound is the mixing of any number of matters, either fluids or gasses or chemicals together in one mass. So when we mix air and atmosphere together we have a simple compound, but by this compound we have found a prismatic vapor and this compound of air is supposed to exist only 45 miles above the earth, and above this point all is darkness, as this prismatic vapor is the true origin of both light and heat.

The author is right; his "artickle" does contain "some ideas that has never been advansed," at least we have never "sene" them before.

CORNELL UNIVERSITY: HER GENERAL AND TECHNICAL COURSES. By Frank C. Perkins. (John Wiley & Sons, New York; price, $1.50.)

The reason for this book is not very apparent. It contains a brief account of the origin of Cornell University, which is followed by condensed descriptions of the different departments, written apparently to measure, since each occupies exactly a page, while the opposite page is taken up by an engraving showing the building devoted to the department, with a portrait of the professor in charge. There is an undue proportion of advertising—just one-third of the pages being given up to advertisements. We do not by any means wish to depreciate advertising or detract from its value; but in a book intended for permanent preservation, so large a proportion seems out of place. The engravings will doubtless be valued by graduates of the University; but beyond the pictures there is really nothing in it which cannot be found in a somewhat different—and probably more complete—form in the yearly catalogue of the University.

One thing must be said of the book, however—that the mechanical execution is very good. It is well done; and the printers—the Matthews-Northrup Company, of Buffalo—have obtained better results from the half-tone cuts than it is always possible to secure.

BEESON'S SAILORS' HANDBOOK AND INLAND MARINE GUIDE: 1891. By Harvey C. Beeson, late Marine Clerk of the Port of Detroit. (H. C. Beeson, Detroit, Mich.; price, $1.)

This handbook must be almost indispensable for lake shippers and navigators. It contains lists of all the American steam and sail vessels on the Northwestern Lakes; tables of sailing distances between lake ports; names of harbor-masters, port and customs officers; lists of light-houses, beacons, etc.; rules of the road; rules for pilots, and much other useful information, besides a variety of articles on ships and shipping and on maritime law and recent decisions. In a word, it may be said to be an almost complete compendium of information of the kind which a shipper or captain needs, arranged in a convenient way and given in a condensed form. The labor of pre-

paring such a book is not small, and the author deserves credit for the care with which it has evidently been done.

H. M. S. "VICTORY: HER HISTORY AND CONSTRUCTION. *With Special Reference to the Reproduction of the Ship at the Royal Naval Exhibition.* By Captain C. Orde Browne, R.A., and Assistant Constructor H. J. Webb, R. N. (*The Engineer*, London, England).

This is a descriptive and historical account, reprinted from the columns of *The Engineer*, of the famous old *Victory*, which in its prime was Lord Nelson's flagship, and took a prominent part in many famous naval battles. The historical part is, of course, very interesting; and the fully illustrated description of the ship is still more so, as a study of what was the best naval practice a century ago.

The contrast between the *Victory* and a modern war-ship is well shown by her armament. She was launched in 1765, and when she first went into commission carried 104 guns, as follows: Lower deck, 30 long 32-pdrs.; middle deck, 30 long 24-pdrs; main deck, 32 long 12-pdrs; upper deck, 12 short 12-pdrs. The "long 32s" were the heaviest navy guns of that day, and weighed 56 cwt. each; rather a contrast to the 110-ton guns of the *Benbow* or the *Anson*.

The care with which the *Victory* has been preserved and the interest with which she is regarded suggests a regret that some one at least of our own famous ships has not been preserved as an example. The old ships which first made the reputation of our navy are gone past recovery; but we still have the *Hartford*, the *Kearsarge*, and one or two others which have earned a name as fighting ships, and one of them at least ought to be kept for future generations instead of being broken up when her usefulness as a cruiser is over.

This monograph on the *Victory* is of interest to general readers as well as to naval men, and *The Engineer* has done them a service in reprinting it in a form convenient for reference.

EXPERIMENTAL INVESTIGATIONS BY THE STATE BOARD OF HEALTH OF MASSACHUSETTS UPON THE PURIFICATION OF SEWAGE AND THE INTERMITTENT FILTRATION OF WATER. *Made at Lawrence, Mass.*, 1888–90. (Boston; State Printers.)

This is Part II of the Report on Water Supply and Sewerage presented by the Massachusetts Board of Health. Part I treated of Water Supplies and Inland Waters.* The present volume gives the result of a long series of tests and experiments made under the direction of the Board, with a view of securing exact data; these were conducted at a station established for the purpose on the Merrimack River near Lawrence.

The principal part of the book is the Report on Filtration of Sewage and Water and Chemical Precipitation of Sewage, by Mr. Hiram F. Mills, a member of the Board, who had special charge of this work. This is followed by a report on the Chemical Work of the Station, by Dr. Thomas M. Drown and Allen Hazen; a report of Experiments on Chemical Precipitation of Sewage in 1889, by Allen Hazen; a report of the Biological Work of the Station, by Dr. W. T. Sedgwick; and lastly, investigations upon Nitrification and the Nitrifying Organism, by E. O. Jordan and Ellen H. Richards. The work is illustrated by a number of plates and diagrams, and is provided with an excellent index, a point too often neglected in reports of this kind. The whole forms a great body of information on the subject which must be of much value to the sanitary engineer.

With the modern tendency to concentration of population in towns and cities the questions of water supply and the disposal of sewage and refuse have come to be of the first importance. Too much work has been done in a blind, haphazard way, and the value of systematic investigations like those undertaken by the Massachusetts Board can hardly be overestimated. Undertaken in the first place for the benefit of the people of that State—peculiarly a State of cities and large towns—the results are applicable and useful everywhere, and a careful study of this volume will be well repaid.

* See JOURNAL for June, 1891, page 244.

REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK ON STRAINS ON RAILROAD BRIDGES OF THE STATE. William E. Rogers, Isaac V. Baker, Jr., Michael Rickard, Commissioners; Charles F. Stowell, Bridge Engineer. (Albany, N. Y.; State Printers.)

The work of which this report is the result was undertaken by the New York Railroad Commission in 1884, when it had become apparent that some measures were necessary to secure a proper knowledge of the strains on railroad bridges throughout the State, and of the ability of the bridges to support them. A circular was then issued by the Board requiring railroad companies to submit strain-sheets of their bridges, and when these were received they were submitted to the inspection of Mr. Stowell as Engineer.

As there are about 2,500 railroad bridges in the State, the work to be done was very great, and it is not at all strange that several years have been occupied in doing it. That it has been thoroughly done the volume before us is evidence, containing as it does 1,876 pages closely filled with diagrams and tables.

The effect of this examination has been excellent, as is shown by the following paragraph from the preface:

> The result has been that managers found weak places in many of their bridges, of which they had had no idea. The mere fact that a strain-sheet had to be calculated by some one competent to do so brought to their attention defects, of which they might have remained in ignorance until awakened by a disastrous accident. In many cases the bridges were strengthened before the drawings and strain-sheets were sent to the office of the Board.

The Railroad Commission has made it a practice, when any defect is discovered, to notify the railroad company at once and require the bridge to be rebuilt or strengthened. There can be no doubt that this work has added substantially to the safety of railroad travel in the State.

ELECTRICITY AND ITS RECENT APPLICATIONS. By Edward Trevert. (The D. Van Nostrand Company, New York; illustrated, 350 pages.)

This is intended to be a practical book for students and for amateurs rather than a profound scientific treatise. It describes the later developments in electrical work in a way which can easily be understood by those who are not thoroughly versed in the science, and has more especial reference to the practical applications of electricity than to any theory in relation to it.

Among the subjects treated are Batteries; Dynamos; Field Magnets; Armatures; Telegraph and Telephone; Arc Lights; Incandescent Lights; Motors; Electric Railroads; Electric Mining Apparatus; Electric Welding; and a variety of others of less importance.

An appendix contains tables of electric measurements and a dictionary of terms used by electricians. The latter will be very convenient, especially to the general reader who wants to acquire some knowledge of electrical work, and to this class the book will be very acceptable. It contains much information, conveyed in a way which makes it possible to read it without having any extended knowledge of scientific electricity.

The book is fully illustrated, and the engravings are generally good, though a few have been admitted which are not up to the standard of the books. These are exceptions, however, and most of the cuts are good. The book will be found very useful for those who wish such a general understanding of the subject as will enable them to speak of it with some knowledge. For students also it is an excellent work.

GEOLOGICAL SURVEY OF NEW JERSEY. *Annual Report.* By John C. Smock, *State Geologist.* Trenton, N. J.; State Printers.

The work so well begun by the late Professor Cook is being steadily carried forward to completion under his successor. The Geological Survey proper is nearly completed, it is true, but much other work in connection with it is still to be done. The special reports on the geology of the northeastern section of the State, and on the Iron Mines, are among the subjects treated in the present volume.

Two important studies are now in progress, one being on the Water Supply and Water Powers of the State, including the kindred subjects of Drainage and Artesian Wells. The other is the preparation of maps showing the structural geology and the nature of the overlying soils. The first will show the rock formations, irrespective of the surface; the second will be properly an agricultural map, and will show the nature of the soils, their distribution, the outcrops, etc.

Special reports in the present volume are on the Geodetic Survey; on the Terrace Formations of the Atlantic Coast; on Water Supply and Water Power, and on Drainage. There are also valuable papers on the Iron Mines and on the Limestone Formations of Sussex County.

The Geological Survey of New Jersey has done thorough and excellent work, and the examination of water supply will add to the value which its studies have had for the State. It has been in good hands from the beginning, and in many respects might well serve as a model for other States. Its publications are an example of this; and almost the only fault that can be found with them is that they are too modest in their statements, leaving the importance of the work accomplished to be inferred rather than directly stating it.

## TRADE CATALOGUES.

*Construction and Use of Universal and Plain Grinding Machines, Cylindrical and Conical Surfaces, as made by the Brown & Sharpe Manufacturing Company, Providence, R. I.*

This book contains a brief general introduction on grinding machinery; an illustrated description of a number of special machines made by the company, and finally a chapter on the care and use of the tools described. This makes it somewhat more than a mere catalogue, for it contains many useful hints and much information that will be of value to the foreman and shop owner.

The reputation of the company is such and the character of the tools it manufactures is so generally known that it is hardly necessary to speak of them here, except to say that the list contains a number of machines adapted to special work of various kinds, as well as to general work.

*Hewlings' Directory of Steam Specialities and Engineering Appliances. Published by A. J. Hewlings, Chicago.*

This book is intended to give as complete a catalogue of manufacturers of steam specialties as can be compiled, and the publisher has collected a large number of names of persons engaged in that line of business. There are also a large number of advertisements, every other page being given up to them, so that the book is quite convenient for reference to those in the trade, or to those who have occasion to buy steam fittings and appliances, as almost every one in business has to do now.

## BOOKS RECEIVED.

*Engineering Association of the South: Selections from Papers Presented during the First Fiscal Year, November* 21, 1889, *to November* 13, 1890. Nashville, Tenn.; printed for the Association. This contains the more important papers read before the Engineering Association of the South last year, including an illustrated description of the Louisville & Jeffersonville Bridge, an account of the Natchez Water Works, and several others.

*Report on the Internal Commerce of the United States for the Year* 1890. *Part II of Commerce and Navigation.* By S. G. Brock, Chief of the Bureau of Statistics, Treasury Department. Washington; Government Printing Office.

*What is Forestry?* By B. E. Fernow, Chief of the Division of Forestry, Department of Agriculture. Washington; Government Printing Office.

*Washington and Lee University: Catalogue*, 1890–91, *and Announcements*, 1891–92. Lexington, Va.; issued by the University.

*Report of the Director and Treasurer of the Michigan Mining School.* Houghton, Mich.; issued by the School.

*Reports of the Consuls of the United States to the Department of State. No.* 128, *May*, 1891. Washington; Government Printing Office.

*Statistical Abstract of the United States*, 1890; *Thirteenth Number. Finance, Coinage, Commerce, Immigration, Shipping, Postal Service, Railroads, Agriculture, etc. Prepared by the Bureau of Statistics under the direction of the Secretary of the Treasury.* Washington; Government Printing Office.

*Car Lubrication.* By W. E. Hall, M.E. New York; John Wiley & Sons (price $1). This book is received too late for review in the present number.

*The Hawkeye: Junior Annual of the Class of* '92, *State University of Iowa.* Iowa City, Iowa; published by the Class. This is the yearly book representing the Iowa University from the students' point of view, and gives many interesting details concerning that institution.

*Catalogue of the Pratt Institute*, 1891–92. Brooklyn, N. Y.; published by the Institute.

*Annual Report of the Bureau of Steam Engineering to the Secretary of the Navy.* George W. Melville, Engineer-in-Chief, U.S.N. Washington; Government Printing Office.

## TECHNICAL SCHOOLS.

THAT there is a growing demand for technical rather than general schools is shown by the increase in the number of students in existing technical schools, and by the increase also in the number of those institutions and in the appliances provided by them for the student. A general training no longer suffices to fit the student for work; engineering now includes so wide a range of work that it is necessarily becoming every year more subdivided and specialized, and some, at least, of the schools are recognizing this fact and making their arrangements accordingly, as is shown by several catalogues and other documents lately received, and now before us.

The University of Illinois, at Champaign, last year had 184 students in the engineering classes, of whom 95 were studying civil engineering; 78 mechanical, 5 mining, and 1 electrical engineering. In addition it had 73 students in the closely allied branch of architecture. These together made up about one half of the whole number of students. In the several courses laid down an effort has been made to combine as much practical work as the time will allow, with the necessary theoretical instruction which is the basis of the whole. The instructors include Professors Ira O. Baker (Civil Engineering), Arthur N. Talbot (Municipal Engineering), and Arthur T. Woods (Mechanical Engineering).

Another Western institution which attracts many students of engineering is Purdue University, at Lafayette, Ind. Under

Professors Goss, Phillips, Creighton and others much improvement has been made in the courses and methods of instruction, besides additions to the plant. The civil engineering department has a fair equipment, and there is a large and well-supplied mechanical laboratory where experimental work can be carried on, and where practical instruction in forge and foundry work, iron fitting and woodwork can be given.

To a certain extent it is true that school instruction can never take the place of actual work in the shop, but it may be an excellent preparation for the student, and help him by showing how the theoretical knowledge he obtains can best be applied in practice.

The standing of Sibley College, the engineering department of Cornell University, has long been known, and it is only necessary to say that under Professor Thurston and his colleagues large additions have been made to the plant both for mechanical and electrical work. Last year over 450 students were enrolled there.

The University of Pennsylvania is now making additions to its buildings in West Philadelphia, with a special view to enlarging the department of mechanical engineering. A new building 80 × 45 ft. is being put up for this purpose. In the basement will be placed the engines and dynamos which supply light to all the buildings, and these will also serve as part of the plant used in instruction. The upper floors will contain workshops, drawing-rooms, and recitation-rooms. This will form a great improvement and addition to this department of the University, hitherto cramped in its operation by want of room and proper appliances. The special engineering library has been very much enlarged, though additions are still needed; these will be made as fast as circumstances will permit.

A school of Civil Engineering is maintained by Washington and Lee University, at Lexington, Va.; it is under charge of Professor David C. Humphreys, C.E., and is intended more especially to give the student such a theoretical training as will fit him to undertake the practical work of his profession, with a full understanding of its general principles, thus preparing him to learn more readily the application in the field of those principles.

## ABOUT BOOKS AND PERIODICALS.

A LONG illustrated article on the California Lakes, by Charles H. Shinn, is the principal paper in the OVERLAND MONTHLY for July. Another article describes a visit to Crater Lake in Southern Oregon. The number is, indeed, largely given up to traveling sketches, for Texas and Western Australia furnish material for two other papers. The United States Military Academy at West Point is described by Edgar S. Holden, and an excellent variety of stories and sketches completes the contents.

The JOURNAL of the Military Service Institution for July has for its leading article Artillery in the Rebellion, by General Tidball. Other papers are on the Evolution of Hospitals, by Major Winne; Centralization in Army Affairs, by Colonel Lee; The Summary Court, by R. McK. Powers; Range and Position Finding, by Captain Zalinski; Military Penology, by Captain Pope, and a Chapter of American History, by Captain Ebstein. There are also discussions of several papers, and a variety of translations.

The latest number of the PROCEEDINGS of the United States Naval Institute has for its leading article the Disposition and Employment of the Fleet, by Lieutenant R. C. Smith. Naval Constructor D. W. Taylor gives a new method for calculating the Stability of Ships; Commander F. M. Barber writes of High Explosives in Warfare; Ensign A. P. Niblack describes a proposed system of signals, and Mr. Everett P. Hayden, of the Hydrographic Office, has a very interesting article on the Samoan Hurricane of March, 1889. There is also a discussion of the prize essay for 1891, besides professional notes and other minor matter.

Perhaps the most important paper in the ARENA for July is that on National Control of Railroads, by C. Wood Davis. In the other articles, Plutocracy, Neglected Crimes, the Swiss Constitution, and Theological Thought are among the subjects discussed. This magazine covers a very wide field, and covers it well.

The military article in OUTING for July continues the account of the Massachusetts Militia. There are, besides, articles on Fishing in New Mexico and in Ireland; on Tennis, Polo, Lacrosse, and other athletic games; a historical sketch of Bicycling, and some interesting notes of travel. The number has an unusual variety of illustrations.

In the ECLECTIC MAGAZINE for July there are given articles on the Warfare of the Future, from the *Nineteenth Century;* the Enormous Antiquity of the East, by Max Müller, also from the *Nineteenth Century;* Dust, from *Longman's Magazine;* Ideals of Art, from the *New Review;* and a variety of others from different English magazines and reviews.

In the POPULAR SCIENCE MONTHLY for August the Value of Statistics will be discussed by Hon. Carroll D. Wright, who is a master of the question. The Evolution of the Woolen Manufacture will be concluded, and Dr. Andrew D. White will discuss the epidemics of the past in an article styled From Fetich to Hygiene. There are several other articles of special interest.

The latest number of the NATIONAL GEOGRAPHIC MAGAZINE is devoted to Mr. Israel C. Russell's report to the National Geographic Society on his Expedition to Mount St. Elias in Alaska. It is illustrated by maps and photographs, and contains a great deal of information about the hitherto almost unknown regions of Alaska.

In the August number of HARPER'S MAGAZINE Colonel T. A. Dodge concludes his paper on Some American Riders. The historical papers on London are continued. An illustrated article on New Zealand gives an excellent general idea of that country and its abundant natural resources. Mr. Montgomery Schuyler gives some Glimpses of Western Architecture, the city of Chicago furnishing the text for his present paper. There is, besides, a great variety of lighter articles, stories and sketches.

The August number of SCRIBNER'S MAGAZINE is a "fiction number," chiefly devoted to short stories. There is, however, an article, in the Street Series, on Piccadilly, the great street of London, and one on the new Parliament of Japan.

That excellent paper, the AMERICAN MANUFACTURER AND IRON WORLD, of Pittsburgh, appeared on July 4 in a new dress, and at the same time abandoned its former large sheet, adopting a page about the size of that of the JOURNAL. The *Manufacturer* has always been readable and reliable, and in its new form is much more convenient and attractive than before. It should continue to enjoy the prosperity and influence which it has well earned.

The July number of BELFORD'S MAGAZINE is a very good one; so much so that it would be hard to specify any particular article as the leading one. There is no lack of the more serious and controversial articles for which this periodical is making a reputation; while the summer reader who looks merely for amusement will find lighter matter enough to satisfy his or her wishes.

In GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for July there is an article by Mr. C. DeKalb, which gives an excellent condensed account of the railroad systems of South America, their past growth and future prospects. Among other articles of interest are Geographical Progress in England; Tea Planting

in Ceylon; the City of Toronto; Completing the Exploration of Australia, and the Cañons of the Colorado. This magazine contains much that is of interest not only to the student, but also to the business man and the general reader.

## THE UTILIZATION OF NIAGARA FALLS.

(Condensed from a lecture delivered by Mr. Coleman Sellers before the Franklin Institute, Philadelphia; published in the *Journal* of the Institute.)

THE extent of the area supplying water to the Falls of Niagara is so well known in a general way that it is only necessary to say that the drainage basin includes an area of over 240,000 square miles. The Falls are 23 miles below Lake Erie and 14½ miles above Lake Ontario. The total difference between the water levels of the two lakes is 326 ft., which is distributed as follows: Rapids between Lewiston and the lower Suspension Bridge, 100 ft.; rapids between the Bridge and the Falls, 10 ft.; the Falls of Niagara, 160 ft.; rapids immediately above the Falls, 50 ft.; Upper Niagara River, 6 ft. The extreme limit of variation in the depth of the river above the Falls is 3½ ft., but the limit is very rarely reached. Generally a variation of 1 ft. above the Falls is followed by a change of 5 ft. below. These changes are of short duration, and are generally due to long continued violent winds or sudden accumulations of ice. The average discharge of water from Lake Erie into the Niagara River is estimated at 265,000 cu. ft. per second. The flow is for all practical purposes unlimited and never failing.

The plan which is now being worked out by the Cataract Construction Company was originally suggested by Mr. Thomas Evershed, and when taken up by the Company was referred to Mr. Coleman Sellers as Consulting Engineer. Under his charge, and under that of Mr. Adams, the President of the Company, a commission was formed consisting of Sir William Thomson, of London; Mr. Sellers; Colonel Turrettini, a distinguished Swiss hydraulic engineer; Professor C. E. Mascart, of Paris, and with Professor W. C. Unwin, of London, as Secretary. This Commission asked for plans for the generation of power by turbines or other water moters, and for the transmission of power so generated. A large number of these were received and carefully considered. The whole were based on the work which the Company has already begun, and which is stated as follows:

The Niagara River above the Falls flows from the east to the west, and at the Falls the lower gorge, into which the water is carried by the two great Falls, the American and the Horseshoe, runs almost due north toward the west end of Lake Ontario. Between the line of the New York Central Railroad, as it enters the town of Niagara and the river bank is a strip of land averaging sufficient width to permit the laying out of a manufacturing town as an extension of the town of Niagara, with room sufficient to permit a long canal from the river to run parallel with the railroad, to enter the river below Grass Island with a diverging mouth of sufficient width to, of itself at its lower end, give water at the Central Station to the whole amount required if need be.

Streets are being laid out above Port Dey, where the existing hydraulic canal takes its water, for the location of mill sites, while farther up the river a large area of land, in all about 1,400 acres, will be reserved for dwellings of the operatives in conjunction with other large areas not owned by the Niagara Power Company, but being worked in harmony with it.

A tunnel requiring about 490 sq. ft. of rock excavation is being driven from above Port Dey on the land of the Company under the town of Niagara to a few feet below the Upper Suspension Bridge, a total length of 6,700 ft., to be extended up stream farther as required when the mill sites may be occupied. Only the lower end of the surface canal, as designed to feed the wheels that are to discharge into the tunnel, will be at present built, as from this point all the business will be allowed to grow upon the lines presently to be pointed out to you.

The tunnel will pass under the existing hydraulic canal that feeds the mills, which at present exist in the town of Niagara on the bank below the Falls. This canal has been in operation for about 40 years, and begins at Port Dey, at the immediate head of the Upper Rapids of the American Fall; Port Dey taking its name from one who was largely interested in the enterprise, and who has been noted for his connection with the manufacture of india-rubber in the United States. The canal passes through a reservation 100 ft. wide, but is only 35 ft. wide, and carries the water into a forebay parallel with the lower river, whence various factories are being fed. The whole amount of water that this canal will deliver is already exhausted so far as the power it is capable of yielding is concerned, with at present an operating efficiency of about 6,000 H.P. This power may be increased to double the amount by utilizing all the available fall, but it cannot be increased beyond that without deepening or widening the existing canal.

It may be noted here, that the mills that are fed by this hydraulic canal have been conducted with profit to their owners, on account of the steadiness of the water-power and the many advantages offered by Niagara as a site for manufacturing operations, as well as the great railroad facilities that have been for a long time in existence.

The reason for adopting a tunnel for a tail-race and placing the mill sites above the Falls was that land for manufacturing purposes was not available along the lower river, and that public opinion is very much against placing factories on the banks of the Niagara to the detriment of its picturesque features. A large part of the land also belongs to the State of New York, and is used as a public park. Moreover, water cannot be carried by canals for use in water wheels at nearly so rapid a rate as the tail or waste water from the wheels can be distributed through the tunnel. In the canal the velocity cannot safely be made much over 3 ft. per second, while in the tunnel the water may be carried at as high a speed as 25 ft. per second, so that the dimensions of the tunnel for the waste water can be very much less than would be required for the canal.

In utilizing this power it has been decided that a certain amount will be sold for local mills which will control their own wheels and deliver water into the tunnel. Beyond this the power will be retained entirely under control of the Company, and the plans formed are as follows:

There will be a central station for the generation, first of about 5,000 H.P. by compressed air, another one of 5,000 H.P. by electricity, with the possible extension of either one of these to the amount of 100,000 H.P. added in units of 2,500 to 5,000 H.P. to either, one by one, in whichever direction proves the most profitable and is called for by manufacturers. The Company is anxious to do this work cautiously, economically and thoroughly and to avoid mistakes. With this intent the matter has been placed in the hands of a Board of Engineers, of which Coleman Sellers is now the Chairman, with Colonel Turrettini as foreign Consulting Engineer, and Mr. John Bogart, the State Engineer of New York, as Consultant with Mr. Sellers, Mr. Clemens Herschel, the Hydraulic Engineer of the Company, and Mr. Albert H. Porter, the grandson of the one who originally owned Niagara Falls, as the Resident Engineer of the Company at Niagara.

Since this address was delivered, Mr. George B. Burbank, C.E., has been made Resident Consulting Engineer at Niagara Falls.

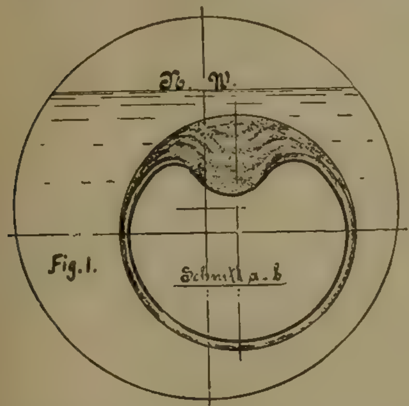
It is not probable that the whole amount of 120,000 H.P. will be used for a long time to come. It may be stated that the use of compressed air for the transmission of power has been adopted on account of the success attained with that method in Rome, in Paris, and elsewhere abroad, and it may be mentioned that this method has been used in several places where electrical transmission could not be conveniently applied. It is stated by the best authorities that 50,000 H.P. can by this method be carried 20 miles through two pipes each 26 in. in diameter, with a certainty that by increasing the pressure for the time being one pipe only might carry the entire amount, while the other one would be under repair. As to transmission by electricity, its capacity is already well known, and there seems to be practically no limit to the amount of power which can be conveyed in this way.

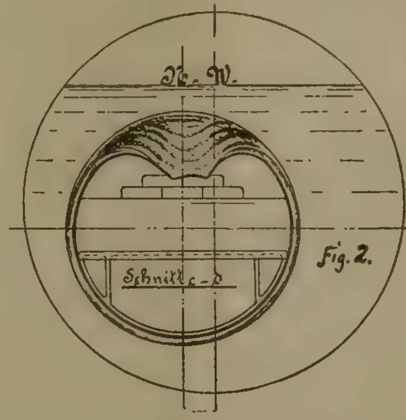
The work of the Cataract Construction Company is now being pushed rapidly, and Niagara is already being taken into consideration as a location for factories. A single firm has already leased 3,000 H.P. to be used for pulp mills and paper works, and the building of the factories is to be begun at once.

The lecture gives many other interesting particulars as to the transmission of power for long distances, and as to the methods which have been adopted for utilizing water powers in Switzerland and elsewhere.

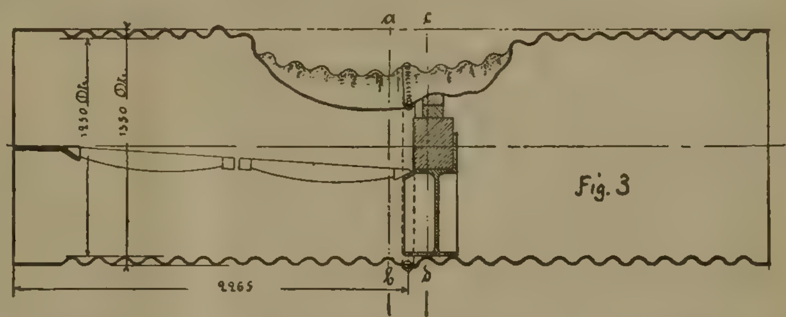
The figures show very well the peculiar form which the furnace assumed; they also show that the failure occurred directly over the bridge wall—that is, at the point where the roof of the furnace is subjected to the greatest heat.

The boiler in question was built in 1882, and was a cylinder boiler with internal fire-box. The boiler is 7 ft. 3



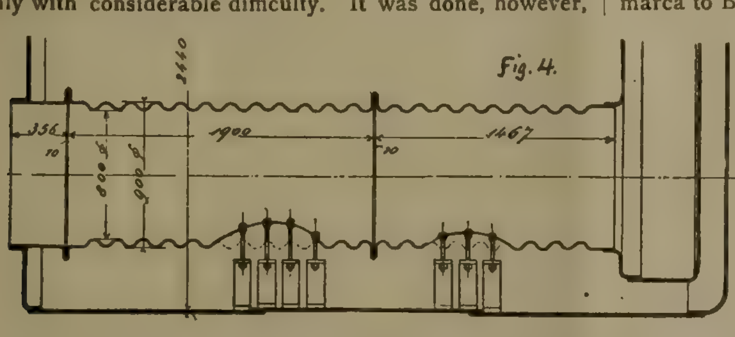



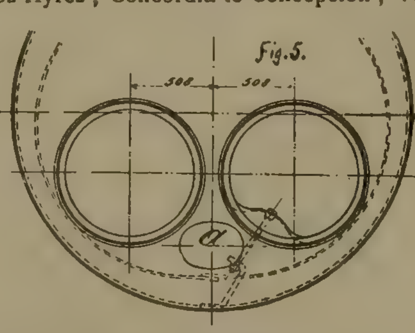

in. in diameter and 32 ft. 10 in. long. The corrugated tube forming the fire-box is 13 ft. 11 in. long, the grate extending about half the length; the diameter outside is 53 in., and inside 49 in.; the thickness of the plate being $\frac{7}{16}$ in. It was of the Fox pattern, and was made at the Schultz-Knaudt Works in Essen. Examination showed that the steel was of excellent quality, and in fact it was forced down into the bridge, making indentations in the hard fire-brick. The boiler was licensed, after inspection, to carry a pressure of 90 lbs.; the usual working pressure was 75 lbs. In ordinary work the consumption of fuel was about 18 lbs. per square foot of grate per hour, and about 4½ lbs. of water were vaporized per square foot of heating surface per hour.




No fault could be found with the material used; but it is possible that some better method of staying the furnace than that in use might have prevented a collapse.

In figs. 4 and 5 another case of partial collapse of a corrugated furnace is shown, with the means adopted for making temporary repairs. Fig. 4 is a horizontal section, and fig. 5 a cross-section. In this case the boiler was in use on the steamer *Kolomna* on the Caspian Sea. The water of this sea is very bad, and a thick deposit formed on the outside of the fire-box, which was probably the cause of the collapse. Deformations of the fire-box appeared in two places, as shown in fig. 4. The scale was so heavy that the man-hole *a*, fig. 5, could be broken open only with considerable difficulty. It was done, however,




and the fire-box was secured by stay-bolts arranged in the manner shown in the sketches, so that the boilers were continued in use and further collapse prevented.

In this case the deformations of the fire-box were on the lower side, the larger one being below the grate, and the smaller one behind the bridge-wall, so that they did not happen at the point where the heat was most intense, but at that where the scale was thickest.

## ARGENTINE RAILROADS.

THE following statements are from the official report of the Secretary of the Interior of the Argentine Republic, which is dated May 1 last:

From January, 1890, till March 23, 1891, the following new railroads or sections have been opened to traffic:

1. Central Argentine branch from Cañada Gomez to Pergamino.
2. Buenos Ayres & Rosario prolongation from Pinto to Tucuman, besides branches to Santo Tome, etc.
3. Northwest Argentine from Caseros to Mercedes, and from Corrientes to Saladas.
4. Southern of Santa Fé to Venado Tuerto and Carlota.
5. Bahia Blanca Northwestern to Bernasconi.
6. Transandine, from Mendoza to Uspallata.
7. Great Northern, from Salta to Santa Rosa.

We have also approved the plans of the following:

1. Bahia Blanca to Ruffino, Pelleschi's concession, by way of Trenquelauquen, 353 miles, with a guarantee of 5 per cent. during 20 years on a cost of $12,600,000.
2. Mendoza to San Rafael, Bemberg's concession, with a 5 per cent. guarantee on $22,750,000.
3. Pilar to Campana, Meiggs's concession, without any guarantee.

We cancelled the following concessions: Parana to Tartagal; Villa Maria to Reconquista; Ituzaingo to Posadas; Buenos Ayres to Riachuelo; Chacari to Trenquelanquen; Rio Quinto to Rosario; Metropolitan Railroad; Zarate to Toay; Tigre to San Roque; Nuñez to Riachuelo; Villaguay to Colon; San Nicolas to Rufino; Catamarca to Buenos Ayres; Concordia to Concepcion; Villa Maria to Mendoza; San Rafael to Norquin; Capilla to Giles.

On January 1, 1891, there were 30 railroads in construction or survey with a total length of 12,600 kilos, or 7,800 miles, including four State railroads with a length of 440 miles, and 12 lines holding Government guarantees with a length of 4,030 miles, besides 19 others. In 1889 there were 5,150 miles of railroad open for traffic, and in March, 1891, no less than 7,310 miles.

The above lines employed 18,960 persons, and represented an outlay of $297,500,000. There were 11 of the above lines holding Government guarantees, amounting in all to $4,600,000 yearly.

## RECENT EXPERIMENTS WITH ARMOR-PLATES.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Concluded from page* 317.)

### FROZEN ARMOR PLATE.

An interesting experiment was made at the Annapolis Proving Ground, in November last, to test the effect of frost upon nickel armor-plate, as it had been thought that this metal might develop excessive brittleness at very low temperatures. In carrying out this experiment it was intended to fire three shots at the nickel-steel plate used in the September trials—one when the plate was at the normal temperature, a second after it had been frozen, and the third when it had returned to its original condition. Only the first two were fired, however.

The plate was mounted as before, only the distance from the gun was increased to 263 ft. The gun, the powder charge, the kind and weight of projectile were the same as in the previous trials. The first shot was fired with the temperature of the plate at 53°, and was directed on the central line to the left of the 8-in. perforation. After entering the plate 13½ in. and getting its nose into the backing, the projectile rebounded and was picked up 40 ft. from the target, somewhat cracked and slightly set up. Two apparently through cracks were started in the plate. To freeze the plate, a box a foot in depth was built in front of its face and filled with salt and ice, arrangements being made for taking the temperature at the top and one of the lower corners of the plate. When the temperature had fallen to 28° and would go no further, the box was cut away sufficiently to admit the aiming of the gun, and a second shot fired, the ice being allowed to remain on the plate until the last moment. The penetration of this shot, directed on the central line to the right of the 8-in. perforation, was about the same as the previous one; a number of new cracks were started, principally in the neighborhood of the old shot-holes, and a large piece was broken from across the top of the plate and thrown to the front. The projectile broke up badly, leaving its point in the backing. Except for the breaking up of the shot, there was nothing to indicate any additional hardness or brittleness in the plate on account of lowness of temperature. As this might well have been the fault of the projectile itself, it is understood that the conclusion reached by the Board was that the temperature reached had no appreciable effect upon the metal.

### TRIAL OF A BETHLEHEM STEEL PLATE.

On January 20 last there was a trial of an experimental Bethlehem press-forged, oil-tempered steel plate at the Annapolis Proving Ground. Its dimensions were 6 ft. × 4½ ft. × 11½ in., secured by four bolts to a 36-in. oak backing. The gun used was the 6-in. B. L. R. used in the September trials. The projectiles were Holtzer armor-piercing shell, weighted to 100 lbs.

Three rounds were fired, the first with a charge of 48 lbs. of brown prismatic powder. The striking velocity was 2,032 foot-seconds; the striking energy 2,862 foot-tons. The projectile penetrated 12⅝ in., rebounded 25 ft. to the front; was shortened 0.1 in., but otherwise intact. A front bulge of 1 in. was raised and a projecting fringe ⅝ in. higher. A number of short radial cracks were developed in the bulge. At the second round the charge was increased to 48½ lbs., raising the striking velocity to 2,065 foot-seconds and the striking energy to 2,956 foot-tons. The projectile penetrated to a depth of 13 in., rebounded entire, 35 ft. to the front, and was shortened 0.1 in. A front bulge and fringe were raised, with short radial cracks, as in the preceding shot. The third shot was fired with the same charge as the second, and the velocities were assumed to be the same. The projectile penetrated a depth of 13⅝ in., rebounded 25 ft. to the front, and broke into two large pieces. A bulge of 1 in. and a projecting fringe of 2 in. was raised on the face of the plate. A through crack was developed from this shot hole to the bottom edge of the plate, and a fine surface crack from third to first shot-hole, and thence to top of the plate. The surface of all the shot-holes was smooth and regular; in the last shot star-shaped cracks extended from the bottom of the cavity through to the backing.

When removed from the backing the back of the plate was found in a remarkably good condition. The back bulges were a little less than 2 in. in height; were uniformly curved, with no cracks around their circumference. Upon the center of the first bulge there were no cracks; upon the second a faint hair crack, while the bulge from the last shot was cracked through. In addition to the through crack to the bottom of the plate, a fine hair crack half way from the bulge of the third to that of the first shot. The backing was not splintered, the indents conforming to the back bulges. A small fragment of fringe thrown off at the first shot was the only metal detached from the plate during the trial.

### THE HARVEY TEMPERING PROCESS.

By the Harvey process of tempering armor-plate, it is the aim of the inventor to secure in one structure the good features of both the compound and the all-steel—that is, the extremely hard face of the one with the tough and elastic mild steel back of the other, without resorting to welding or the creation of any planes or lines of weakness.


Fig. 6.

THE HARVEY PLATE AFTER TRIAL.

The face of the plate to be treated, which may be of ordinary mild steel or of nickel alloy, is, by a method of cementation, the details of which are not known, given a high temper and great hardness; this hardness gradually diminishing toward the interior, while the back of the plate retains the original qualities of the mild steel. This is the claim made by the inventor, and if true realizes what has been so long sought for in armor fabrication.

At the Naval Ordnance Proving Ground at Annapolis, on February 14, a trial was had of a 10½ in. Schneider steel plate, treated according to the Harvey process. The 35-caliber, 6-in. B. L. R. used in previous trials was employed, but mounted, as in the frozen-plate experiment, 263 ft. from the target. Three Holtzer and three Carpenter 100-lb. armor-piercing shell were fired with a striking velocity of 2,065 foot-seconds, and a striking energy of 2,988 foot-tons. All of the projectiles broke up; five of the six were badly shattered after penetrating from 4 to 5 in., leaving their points imbedded in the plate. The head of the remaining projectile penetrated nearly 5 in. beyond the back face of the plate and there remained. The result showed that the face possessed a wonderful degree of hardness, and that there was no disposition to separate from the softer back, but the plate was badly cracked through its entire thickness, although no part of it had fallen from its backing. Fig. 6 shows the appearance of the plate at the end of the trial.

To further test the merits of the Harvey process, a three days' trial was completed at the Naval Proving Grounds on May 8. Five armor plates each 8 ft. × 6 ft. × 3 in. were made especially for this trial by Carnegie, Phipps & Company, of Pittsburgh. One of untreated simple steel,

two of untreated nickel steel—one of low and one of high carbon—and one each of simple and of nickel steel treated by the Harvey process. Twenty-one shots were fired at each plate from a 6-pdr. Hotchkiss rapid-fire gun, using forged steel, armor-piercing projectiles with a striking velocity of 1,800 foot-seconds; the striking energy being considerably greater than was necessary to pierce an ordinary 3-in. steel plate.

The report of this trial says that the untreated steel plate made the poorest showing—nearly all of the projectiles going through, and cracking it badly. The untreated nickel steel, of low carbon, was better, but several of the projectiles went through, while others rebounded and broke up. The untreated nickel-steel plate of higher carbon made a still better record, as it was not cracked, and the greatest penetration was only 3 in. All the projectiles, except one, rebounded and broke up. The Harvey-treated steel plate was considerably cracked, but there was little penetration, and many of the projectiles broke up on the surface. After the trial was over this plate broke into four pieces. The nickel-steel plate treated by the Harvey process was scarcely injured. One of the projectiles scored a penetration of about an inch; the others were shattered upon the surface. The injuries to this plate were insignificant, and confined to one slight crack and a burring up of the surface where the projectiles struck.

Much credit has been claimed in some directions for the behavior of an 8-in. Cammell compound plate in a trial held at Portsmouth in February last. The plate was one manufactured for an Argentine war-ship, and was attacked, at 30 ft. range, by three 100-lb. Palliser chilled iron projectiles. With a striking velocity of only 1,566 ft., the projectiles all went to pieces, with but slight indentations in the face of the plate. The utter worthlessness of chilled-iron projectiles against steel or steel-faced armor-plate has been so often demonstrated that one is at a loss to understand the object or value of this experiment.

### CONCLUSIONS.

In reviewing these experiments one cannot but recognize the fact that the means for thoroughly testing the resisting power of armor-plates were never so good as now. To be able to bring to the trial ground projectiles that are almost indestructible, and ordnance of sufficiently high power to place the attack at a decided advantage, are conditions never before attained. To attack an armor-plate with a gun of insufficient power or with an inferior projectile can only give results that are misleading.

In the Annapolis trials the summary of the Board sets forth very clearly the relative merits of the plates tested. The merits of the nickel-steel were further demonstrated by the handsome manner it held up under the frozen armor experiment of two months later.

In the Ochta trial it is difficult to explain, in the light of that at Annapolis, the relative behavior of the plates. The presence of nickel in the *Schneider* plate was at first questioned, but that it did contain a small percentage of nickel seems to be conceded. That it failed to affect the resisting quality of the metal as at Annapolis is evident. This has been explained upon the two grounds that the quantity was insufficient, and that the low temperature prevailing at the time was detrimental to its resisting powers, although the freezing test at Annapolis did not clearly demonstrate the evil effects of cold upon this kind of armor-plate. The *Vickers'* plate, of hydraulic compressed steel, held together the best of the three, and an order for this armor-plate was given by the Russian Government upon the strength of this trial. It is also understood that an order for the armor for one of the new English battle-ships has been given Mr. Vickers. If so, it will be the first steel-armored ship in the British Navy. The *Brown* plate, unlike the compound plate at the Annapolis trial, showed through cracks, and was pretty badly broken up.

It is to be regretted that the *Wilson* plate could not have been tested by the side of the others. In the test that did take place a few days later it is claimed that it behaved better than either of them. It is intimated, however, but with what justice it is impossible to say, that a good part of the firing against this plate was with soft projectiles. At least it is known that on the day of the first trial it was difficult to find enough projectiles sufficiently hard for the firing. Perhaps it should be said that Schneider excuses the behavior of his plate by saying that it was made more than a year before the one used at Annapolis, while it is known that a test specimen of the *Brown* plate had shown that it was below standard, and that it was contemplated sending another to replace it, but this was not done. No excuses for the *Vickers* plate are on record. Altogether this trial is much less satisfactory than the one at Annapolis.

The experiment of January 20 is noteworthy, inasmuch as the plate tested was the first American steel plate of any considerable thickness to appear upon the trial ground. The showing it made was a remarkably good one. The plate was somewhat undermatched, owing to the fact that the gun was limited to a pressure of 15 tons. This reduced the striking energy nearly 100 foot-tons below that calculated upon to match the plate.

An examination of fig. 6 will show how well the plate treated by the Harvey process fulfilled its mission of keeping out projectiles. It is true that the plate is badly cracked, but no part was dislodged, and if upon the side of a ship, where it would have had the support of adjoining plates, it might have stood a great deal of additional punishment. The penetration of the fifth shot is explained by the Harvey people by the statement that the hardening process at this point was incomplete.

In connection with this matter of through cracking of armor-plates, a writer in the *Engineer* points out the mischievous results that have followed the insistence by the British naval authorities that, whatever other quality armor should or should not possess, there must be, under the impact of a projectile, no through cracking of the plates. He says:

> Originally, it is believed the problem put to our Sheffield makers by the naval authorities was to make minimum liability to through cracks a primary condition; the hardness displayed by steel was to be given, if possible, subject to this leading stipulation—namely, that the plates were on no account to break up and strip off the sides of our ships. . . . This condition may not have been altogether wrong at first, but it has long since become mischievous.

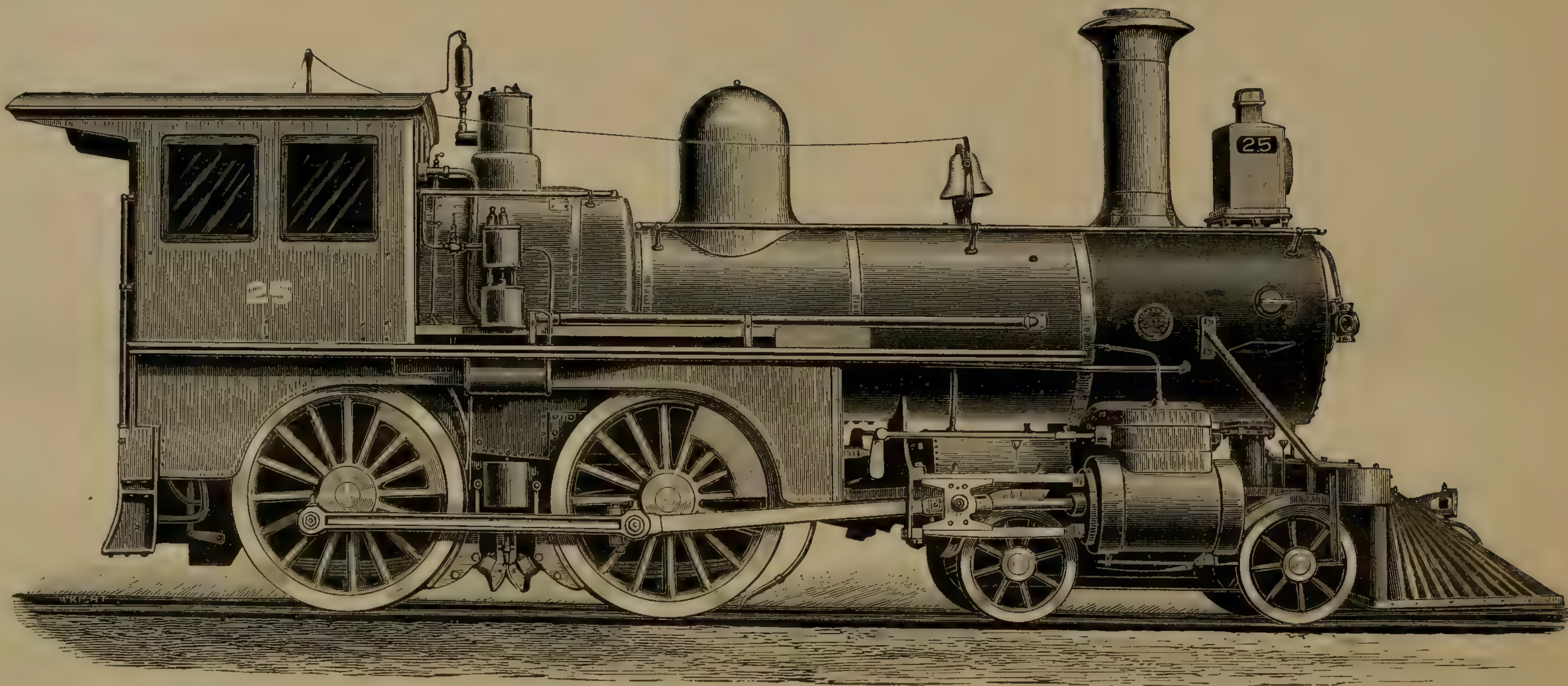
This, perhaps, explains what one may call the blind adherence of the English authorities to compound armor-plate—plate with backs so soft that, while through cracking is rare, its effective resisting depth is reduced one-half.

The ideal armor-plate, for naval use at least, is one that combines maximum resisting power with minimum weight—that is, thickness. The Annapolis trial seemed to show that the nickel-steel plate possessed the long-sought *desideratum*, hardness without brittleness. The Harvey process of tempering armor-plate indicates that it will yet be possible to effectively combine a hard projectile-resisting face with an elastic, tenacious back. When this anticipation is realized it may be said that, with our present knowledge of metallurgy, we shall have attained all that can reasonably be hoped for in this direction.

## THE SAFE HIGH EXPLOSIVES.

(From the New York *Times*.)

THE heavy sentence of four years' imprisonment, in addition to fines, imposed the other day on four persons connected with the alleged sale of the secret of mélinite to the Armstrongs gives a new turn to that strange affair. It was recently announced by the Minister of War that M. Turpin, the inventor, and Captain Triponé, the agent of the Armstrongs, really had nothing of value to the French Government to negotiate for, and that the most important part of the invention—the means of exploding mélinite after it has been united with another substance in the shell—remained in the sole possession of the Government. This second substance is cresilite, a nitro-cresol obtained from a coal-tar product; and after two-thirds of the space in the shell has been filled with it, mélinite is rammed in—a fact which sufficiently indicates that both products can be safely handled, and can be exploded only by a powerful detonator.




PENNSYLVANIA RAILROAD STANDARD PASSENGER LOCOMOTIVE, CLASS P.

BUILT AT THE ALTOONA SHOPS. THEO. N. ELY, SUPERINTENDENT OF MOTIVE POWER.

This mélinite affair has naturally had an interest for all countries that are trying to solve the problem of securing a safe high explosive as the bursting charge of shells used in ordinary powder guns. It seems clear that Turpin made the original invention from which the official mélinite of to-day has been developed, and sold it to the English firm when the French Government was not satisfied with it. The English high explosive known as lyddite, which has been used for several years in experiments at Lydd, has always been spoken of as the invention of Turpin, and it is known to be largely picric acid, which is also the foundation of mélinite. The French were perfectly well aware that the English were using this substance, and that to that extent the secret of safe high explosives for military use was not within their keeping. Indeed, it has been said by good authority that nearly all high explosives for shells are either gun cotton or picric acid compounds. The original objection to the latter was that they were too susceptible to concussion, and would explode before that degree of penetration without which the effect of high explosives becomes of much less importance. But it is evident, from what has already been said, that mélinite does not explode by concussion alone, while the English are said to have pierced several inches of steel with a lyddite projectile before it exploded.

The main point of interest in the matter is that, while in our country attention has chiefly been given to the production of a safe propelling power for high explosive shells, as shown in the pneumatic tubes of the *Vesuvius*, the French have been making the high explosive itself safe for handling and use in ordinary powder guns. The charge of mélinite is not so great as that which can be used in a compressed air gun, but it has the enormous advantage of high velocity, long range and the accuracy and penetration which come of ordinary horizontal shell firing. In the 6-in. gun a shell weighing 121 lbs. has a bursting charge of about 23 lbs. of mélinite; and it is said that in some guns shells charged with 70 lbs. of mélinite have been repeatedly and safely fired with an initial velocity of 1,300 ft. per second.

But France is not alone in this quest. Lieutenant Southerland, of our Navy, in an official publication on the subject, mentions a large number of substances thus employed. One of these is écrasite, which has been adopted by Austria. It is supposed to be a composition of blasting gelatine treated with the sulphate or hydrochlorate of ammonia, is more powerful than dynamite, and is as absolutely safe to handle as mélinite itself. It has been made to penetrate a depth of 8 in. of iron without exploding. The same authority speaks of the Swedish extralite, which is believed to be a picric acid compound, and is also perfectly safe to handle, being exploded only by special means. The experiments with emmensite in our own country are well known, and other explosives have been tested by our naval authorities at Newport, among them being one called bellite. The main fact, that some safe high explosives for the bursting charges of projectiles do exist, seems to be beyond dispute. The mélinite incident in Paris will perhaps increase popular interest in a matter which is likely to be of much importance in the warfare of the future.

## A PENNSYLVANIA RAILROAD PASSENGER LOCOMOTIVE.

THE accompanying illustration, taken from a photograph, shows the latest standard locomotive for general passenger service built by the Pennsylvania Railroad Company at its Altoona shops. This type of locomotive is called Class P by the company.

The boiler is built to carry 160 lbs. working pressure, and is 54 in. in diameter outside of the smallest ring. There are 210 tubes, 2 in. in diameter and 11 ft. 4 in. long. The fire-box is of the Belpaire type, and is 9 ft. 11¾ in. long inside, 40 in. wide, and 50 in. deep in the center. The grate area is 33.26 sq. ft. The heating surface is: Fire-box, 141 sq. ft.; tubes, 1,246 sq. ft.; total, 1,387 sq. ft. The smoke-stack is 18 in. inside diameter. The center of the boiler is 7 ft. 2½ in. above the rail; the total height from the rails to the top of the smoke-stack is 15 ft.

The driving-wheels are 68 in. in diameter and are spaced 7 ft. 9 in. between centers. The total wheel-base of the engine is 22 ft. 8½ in. The rear driving-axle is under the fire-box. The driving-axles have journals 8 in. in diameter. The truck-wheels are 33 in. in diameter.

The cylinders are 18½ in. in diameter and 24 in. stroke. The valve-motion is of the ordinary shifting-link pattern. The throw of the eccentrics is 5 in.; the greatest travel of the valves is 5 in., and they have ⅞ in. outside lap. The steam-ports are 1¼ × 17¼ in., and the exhaust-ports 2½ × 17¼ in. The exhaust nozzles are double, 2¾ × 3½ in. in size.

The tender is carried on two four-wheel trucks and the tank has a capacity of 3,000 gallons. The engine weighs 106,000 lbs. in working order, 65,150 lbs. being carried on the four driving-wheels and 40,850 lbs. on the truck. The weight on the drivers is thus about 8¼ tons per wheel.

## THOUGHTS ON MARINE ENGINEERING.

By ALOHA VIVARTTAS.

(*Concluded from page* 309.)

THE art or science of navigation as taught by Maskelyne, Norrie, Bowditch, Thom, and others consisted principally of rules and methods by means of which the seaman could find and keep the run of his position and desired course during long periods of time, in open sea, under varying conditions of winds, currents, and rates of speed; where generally ample time could be taken to work a "traverse" or post up and compute a "dead reckoning," and where the continual necessity for vigilance kept the captain and all hands *au fait* in the use of all the means aboard with which to accomplish the desired end; where the use of the lead line, not only to decide the actual depth of the water and probable location of the vessel at the time, but also to define the direction and amount of the current or drift when at anchor or becalmed, was never to be forgotten. In all of this the navigator was supposed to use his own head, and judge for himself the speed and leeway at all times; and if near land, no excuse was taken for neglect of any precaution by means of which he could increase his information on these points.

The development of the steamer capable of great and continuous speed has changed the meaning of the word navigation; the art and science has gradually dropped out of sight and out of mind.

The navigator takes a steamer out of port, with his course and speed fixed by rule or custom; the leeway or drift and currents he is to meet are accounted for.

Lights along the beach have multiplied. He rarely hears of a lead-line; the old song "By the deep nine, and a quarter less seven," etc., is a dead language to him; he works no traverse more difficult than getting around a horn or the contents thereof.

He feels no doubt about where he is at any time. He fears no premature approach to a dangerous coast. In fact, to him no coast is dangerous; it is the coaster he dreads and looks out for; like a man crossing a railroad track, his greatest danger is that of being run down.

And to such an extent is this fact recognized by the public and authorities that be, that when "slowed up" in a fog, if he use his whistle well he may drift ashore for want of his lead-line, like one of our finest Sound steamers; or to drift to leeward of his course in a stiff breeze and be wrecked on a well-known reef in clear weather, like another fine steamer; yet the navigator and all of his assistants be held blameless.

The old-time navigator became most anxious and careful when near the coast where many vessels were to be met; but he had not nearly as many vessels to avoid then as are now found on the same ground, nor did any of them travel so fast as many of them do now.

The increase of their speed and the multiplication of the number of the vessels have made a collision the greatest and most to be dreaded danger of the sea to-day—until the

word "collision" has stepped out of the dictionaries into common use within the last fifty years, and has advanced in fear more than in favor, being now probably more used than any other when disasters are to be described. Num-

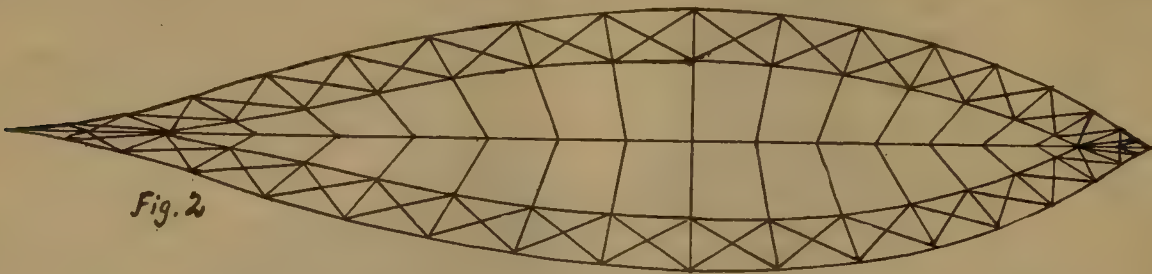


*Fig. 2*

berless inventions are made, and many rules are devised to prevent them; and while every possible care and effort should be made by those in charge to avoid collisions with other vessels, icebergs, rock, or beach, it is also incumbent

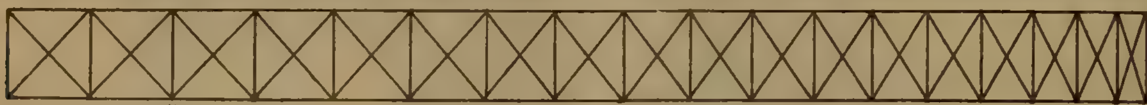


*Fig. 3.*

upon the engineer to so construct his vessel that in the collision which must be expected some time she shall suffer as little as possible.

And in this matter there are several things to be studied

*Fig. 4.*

besides the old style ship. Thus, in the most common case, a collision between two vessels, the blow is generally given and received in a nearly level direction, and is to be best met by strength in the deck. The New York ferry-boat has struck the keynote in this. The deck is the ship *par excellence.* With a sound deck beneath his feet and above water, no seaman despairs; his masts may go by the board, his keel may drop out, but while he can keep his deck above water he feels safe.

A serious defect in ordinary construction, whether of

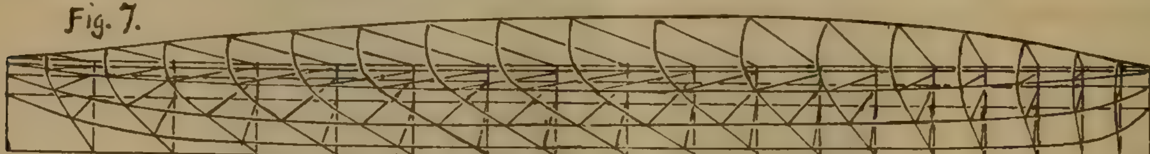
*Fig. 5*

*Fig. 6*

wood or iron, is making the deck practically a rectangular structure with no diagonal bracing. *Nota bene:* "Hanging knees" are never struts, but only crooked fish-plates.

The engineer, recollecting that a blow from without will be most severely felt when received in a direct line toward the center of gravity of his vessel, will set his struts in position to take such blow "end on;" and inasmuch as the vessel is liable to receive such blow on any and every

*Fig. 7.*



point of her circumference, the radial truss of the generic form shown in fig. 2 results as the lightest and strongest form for resisting it.

Next to the danger of collision with other vessels is, perhaps, the danger of going upon the beach; and as this is a trouble which must sometime be endured—for the luckiest ship must sometime rest on hard bottom, if only on a dry-dock—the engineer will meet it by a longitudinal vertical truss through the center of his vessel (fig. 3); and in constructing such truss he will remember that while his bridges keep their perpendicular, and are calculated to resist an attraction of gravitation which acts invariably in a vertical direction, while the only side pressure to account for was the wind, he has now to make a structure which, instead of resting upon fixed supports and carrying a moving load, must carry a comparatively stationary load over moving supports, and many conditions are reversed. Yet he will not, like the old-style ship-builder, neglect his diagonal bracing. Verily, the buildings designed for South American railroads, in view of expected earthquakes, were better braced than are ships which fear nothing so much as a solid and stationary resting-place. But the engineer sees that his vessel must carry her load, although she will not always retain her perpendicular; and also, as from the variations of the levels of her supports, she will sometimes move in a more or less up-and-down direction, and hence is liable to strike a rock or iceberg at any angle from the level plane clear around to the vertical one, he will reinforce his deck and amidship trusses by a system of radiating longitudinal trusses (figs. 4 and 5), sustained by a system of vertical trusses (fig. 6), which will stand in vertical planes radial to the center of gravity of the whole, and therefore agree with the main struts of his deck.

The intersections of the planes of the various vertical and longitudinal trusses will be the positions of his main system of struts, which will, like those of the main deck, stand nearly radial to the general center of gravity, as shown in fig. 7.

This leads the engineer to a kind of spheroidal style of framing, with truss work radiating in every direction, the parts sustaining each other and distributing strains by a corticulated system of members, while the exterior form of the submerged body will vary comparatively little from the smaller craft now in use. For as men have been building small boats for many years, but large ships only a shorter time, so the small boats are, even now, far better models than the larger ones; and many a ship goes to sea which is far less seaworthy than her long boat.

But while below the water-line the small boats are tolerably well shaped for their purpose, above the water-line the form may be varied at will; and there is no excuse for the defects which grow in a geometrical ratio as the boat increases in an arithmetical one.

It will be questioned if such construction will not fill up the hold of the vessel, and so lessen her carrying capacity.

But it is to be remembered that the carrying capacity of any vessel is not to be measured by the cubic contents of the empty space within her, but is only limited by the cubic contents of her outside bulk below the water-line or "displacement," so called because it is exactly equal to the weight of the bulk of water she displaces.

The old practice of building vessels to carry inside and below the level of the water surface as many cubic feet of clear space as possible in proportion to the cubic contents of the outside bulk, has led to the crustacean style of ship-building, and bred many a disaster. Nature tried the experiment ages ago; and all of her large and powerful animals are vertebrate; only a few crabs and lobsters carry their strength entirely upon the surface, like a modern ship. And to-day the term egg-shell is a synonym for weakness. Yet an egg-shell will not break, although falling several times its own diameter, and may ride the surf and come ashore in safety when the strongest ship afloat would be literally broken up, not by the force of the sea, but simply by her own weight, falling a distance less than one half her vertical dimension upon the beach as the sea slipped out from under her.

It is strange that with ages of experience, and many good old rules in various languages forbidding or advising against carrying the center of gravity of the vessel much, if any below the level of the water surface, men claiming some knowledge in sea matters persist in the dangerous practice of putting their weight as low as possible. And yachts with lead on their keels stagger about like men with wine in their heads, neither case being an indication of wisdom.

But if, then, the center of the weight should be kept well up to the level of the water-line, there is no objection to putting the needed strength below it. A dim idea of the fitness of this is floating about in the form of a "double bottom," which is sometimes made, but fails for want of the general truss principle—that is, struts to resist thrust and ties to carry tension. The ordinary iron or wooden ship has material enough in her to insure double her present strength if properly placed. How would our ocean piers stand if built of angle iron, with reverse bars, deck-beams, and outside plating, with internal bulkheads, like an ocean steamer?

The old sailing vessel exhibits a singular phenomenon in having started with a small hulk, which was constructed as a shell, and has been enlarged as a shell, with proportionate loss of strength. But in the matter of sails and rigging the small original started with spars to take thrust and ropes to bear tension, and without change of geometric principles bears enlarging to the needs of the biggest ship afloat, yet holds its strength in proportion to its size. Indeed, there are few, if any better studies in thrust and tension, resolution of forces and distribution of effects than a square-rigged ship properly handled under varying conditions of wind and sea.

An illustration of this is seen in the largest class of derricks as invented by A. D. Bishop, which, copying the geometry of the mast, yard, topping lift, and rolling tackle, by means of which sailors lift and swing their heavier weights, improved upon the details by stiffening the yard in a horizontal plane, increasing the number of topping-lifts, to be always ready for a strain at any point, and carrying the rolling tackle to the "chest trees," as it were, relieving the mast from a short cramp at the slings, without interfering with the side or horizontal swing, thus adapting the machine to the especial work of handling extraordinary heavy weights, without reference to the matter of carrying and handling sails, the primary object of the original mast and yard. These improvements are the improvements of an engineer, not a shipwright, and were first designed and used to handle the heavy stone in the construction of High Bridge over the Harlem River.

## ORDNANCE NOTE.

THE accompanying table, which we reprint from the *Army and Navy Journal*, will be interesting as showing just what has been done by our Army and Navy ordnance authorities toward the armament of our forts and ships since the rehabilitation period commenced. It shows the number of guns and mortars that have been ordered and

UNITED STATES ARMY BREECH-LOADING RIFLED ORDNANCE, 1891.

| Calibres. | Weight. | Tot. Length. | Length of Bore. | Charge. Powder. | Charge. Projectile. | Powder Pressure. | Initial Velocity. | Muzzle Energy. | No. of Guns, &c. Or'd. | No. of Guns, &c. Comp'd. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pounds. | Feet. | Calibres. | Pounds. | Pounds. | Tons, □" | Feet. | Ft.-tons. | | |
| *Mountain and Field Artillery.* | | | | | | | | | | |
| 3-in. Mountain gun, steel | 218 | 3.9 | 14. | 0.88 | 12. | 6.5 | 870. | 63. | 1 | 1 |
| 3.2-in. light field gun, steel | 829 | 7.56 | 26. | 3.75 | 13.5 | 15. | 1675. | 263. | 100 | 75 |
| 3.6-in. field gun, steel | 1181 | 7.56 | 23. | 4.50 | 20. | 16. | 1554. | 335. | 1* | 1 |
| 3.6-in. field mortar, steel | 244 | 2.75 | 5.25 | 1.00 | 20. | 8. | 650. | 58. | 1† | 1 |
| *Siege Artillery.* | | | | | | | | | | |
| 5-in. guns, steel | 3960 | 12.15 | 27. | 12.50 | 45. | 16. | 1830. | 1000. | 11 | 1 |
| 7-in. howitzer, steel | 3710 | 8.06 | 12. | 9.75 | 105. | 12.5 | 1085. | 857. | 11 | 1 |
| *Sea Coast Artillery.* | Tons. | | | | | | | | | |
| 8-in. gun, steel | 14.5 | 23.21 | 32. | 130. | 300. | 16.5 | 1935. | 7787. | 35 | 2 |
| 10-in. gun, steel | 30.0 | 30.60 | 34. | 256. | 575. | 16.5 | 1940. | 15000. | 34 | 1 |
| 12-in. gun, steel | 52.0 | 36.66 | 34. | 440. | 1060. | 16.5 | 1940. | 26000. | 26 | — |
| 12-in. mortar, cast-iron, steel-hooped | 14.25 | 10 75 | 9. | 80. | 630. | 12.5 | 1152. | 5796. | 74 | 1 |
| 12-in mortar, steel | 13.0 | 11.76 | 10. | 100. | 800. | 16. | 1150. | 7334. | 1 | — |
| UNITED STATES NAVAL BREECH-LOADING RIFLED GUNS, 1891. | | | | | | | | | | |
| 4-in. R. F., steel | 1.5 | 13.7 | 40. | 14. | 33. | | 2000. | 915. | 35 | 4 |
| 5-in. R. F., steel | 3.1 | 17.4 | 40. | 30. | 50. | | 2250. | 1754. | 27 | — |
| 5-in. Mark I, steel | 2.8 | 13.5 | 30. | 29. | 60. | | 2000. | 1664. | 2 | 2 |
| 6-in. Mark II and III, steel | 4.3 | 16.3 | 30. | 50. | 100. | | 2000. | 2774. | 125 | 107 |
| 6-in. (35 calibres) steel | 5.2 | 18.8 | 35. | 50. | 100. | | 2080. | 3000. | 1 | 1 |
| 6-in. (40 calibres) steel | 6.0 | 21.3 | 40. | 50. | 100. | 15 | 2150. | 3204. | 2 | — |
| 8-in. Mark II, steel | 13.0 | 21.5 | 30. | 115. | 250. | | 2000. | 6934. | 37 | 15‡ |
| 8-in. Mark III, steel | 13.1 | 25.4 | 35. | 115. | 250 | | 2080. | 7500. | | |
| 10-in. steel | 25.7 | 27.4 | 30. | 240. | 500. | | 2000. | 13870. | 26 | [illegible] |
| 12-in. steel | 45.2 | 36.8 | 35. | 425. | 850. | | 2100. | 25985. | 8 | 1 |
| 13-in. steel | 60.5 | 40.0 | 35. | 550. | 1100. | | 2100. | 32862. | 12 | — |

* Orders for 24 guns await completion of tests of type gun.

† Orders for 16 mortars await completion of tests of type mortar. 25 of the 8-in., 50 of the 10-in., and 25 of the 12-in. will be added to the above next month, when bids will be opened for their construction by private contract.

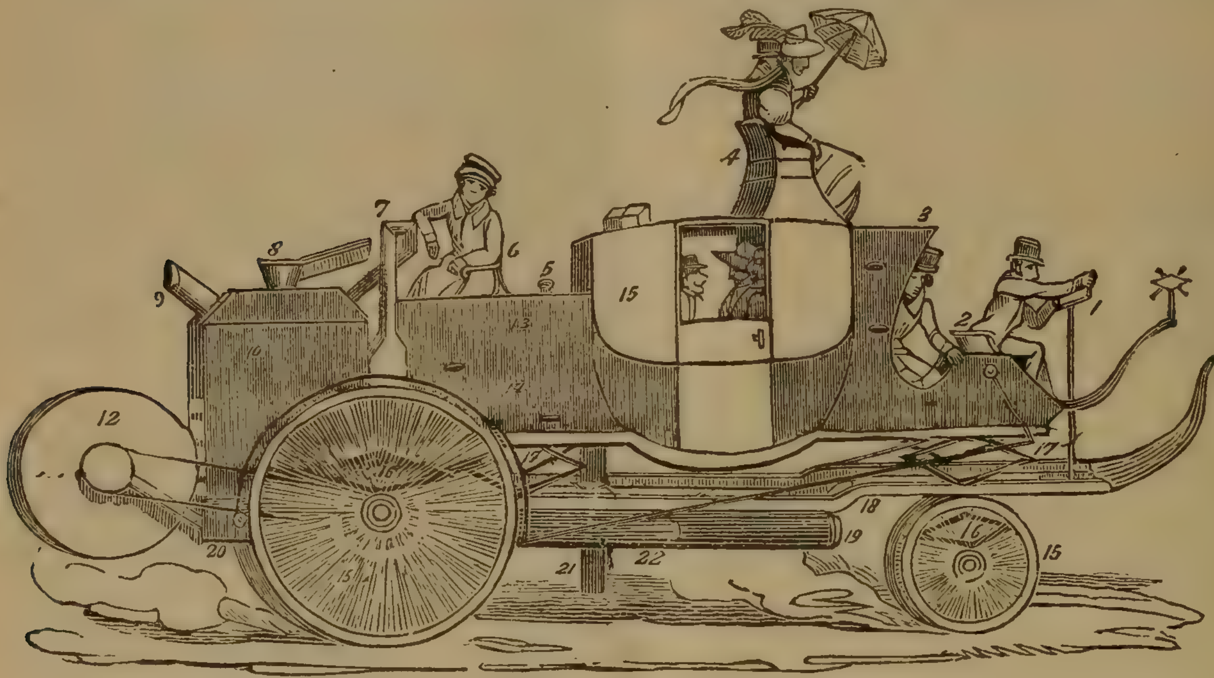
‡ Including six guns of Mark III. Two 8-in. guns of 40 calibres length have been designed.

completed to date. With the exception of a few 4-in. guns, the Navy Ordnance Bureau has ordered all the guns that are necessary for the armament of all the vessels thus far authorized by Congress.

## STEAM CARRIAGES ON COMMON ROADS.

In the June number of the JOURNAL, page 286, there was published an illustration of a steam carriage, invented and built in France by M. Serpollet, for use on common roads. In the description this was referred to as a revival of an old idea. Some correspondents having taken exception to this, we reproduce here, from our old files, two illustrations showing steam carriages, for their information and for the benefit of our readers generally as a bit of history.

The first illustration is from the RAILROAD JOURNAL for November 10, 1832 (Volume I, No. 46), and shows a steam carriage invented and built in England by Messrs. Ogle & Summers. From the account given, it appears that this carriage actually made the trip from Southampton to Oxford and from Oxford to Birmingham, on the latter trip carrying 22 passengers. The figures or numbers of reference on the plate are explained as follows: "1, Helm by which the carriage is guided. 2, Seat for the conductor. 3, Coupé, like French diligences, for four persons. 4, Seat for outside passengers. 5, Hand-pump for filling tanks. 6, Seat for engineer. 7, Pipe for surplus steam. 8, Jigger by which the furnace is fed. 9, Flue or chimney. 10, Boiler. 11, Furnace. 12, Blower, worked by a strap around the axle. 13, Water tank. 14, Brake, regulated by a lever on the conductor's seat. 15, Carriage for eight inside. 15, Wheels, very strong; the spokes not here marked. 16, Springs on which the machinery rides. 17, Springs on which the carriage rests. 18, Frame connecting whole. 19, Machinery under the carriage. 20, Ash-box under the furnace. 21, Pump by which the engine forces water into the tanks. 22, Piston for working the pump."




OGLE & SUMMERS' STEAM CARRIAGE.

*Reprinted from the* RAILROAD JOURNAL *of November* 10, 1832.

No particular description of the machinery is given, except that there were two cylinders, 12½ in. in diameter, and the success of the carriage was attributed largely to the boiler, which was very strong but light, and had a large heating surface for its size. The pressure was carried up to 200 lbs. The speed on the journey varied from 10 to 14 miles on a level; seven miles was reached on a hill.

The second engraving is from the RAILROAD JOURNAL of November 17, 1832, and shows a steam carriage built by Walter Hancock to run between London and Greenwich. At that date it was stated that the inventor had been running it experimentally about a year, and had been for a month working it regularly on the road for hire. The boiler was a special feature of this carriage; it was a sectional or tubulous boiler, composed of tubes connected at top and bottom and held together by bolts; these tubes were surrounded by a cylindrical iron casing, in the bottom of which was the fire-box. This boiler, the inventor stated, had been tested up to a pressure of 400 lbs., but in ordinary working he used from 70 to 100 lbs. Of the machinery no description is given; but apparently the cylinders were connected to the rear axle, the steering being done from the front axle by a chain and pulleys. The engine and boiler were carried on the back end in a large compartment, the front part consisting of two coupés for passengers.

These carriages disappeared when actual trial had proved that steam power could be applied to very much better advantage on a railroad, and the Liverpool & Manchester Railroad trials may be said practically to have put an end for the time to further experiments on steam carriages for common roads.

At present we have nothing to show what was the subsequent history of these two steam carriages. It would be interesting to know how long they continued in use and what finally became of them.

Making some allowance for the imperfections of the old engraving, and for some change in fashion of carriages, the Ogle & Summers carriage does bear a family resemblance to M. Serpollet's new device. Probably the idea will come up again from time to time, and some day it may come into use; but progress is to be made now by small improvements in the engine and generator. The general idea was certainly not new even in 1832, for it antedates the first railroad by many years.

That it has been revived in this country as well as abroad, the Patent Office records will show. Some engineers will perhaps remember also a steam carriage which was built about 1858–61, by an artist named Fisher, in New York, but never quite reached the point of successful work.

## NOTES ON COMBUSTION.

By C. Chomienne, Engineer.

### I.—PRELIMINARY DEFINITIONS.

Chemical combinations are generally accompanied by a greater or less disengagement of heat.

When they proceed slowly, as when iron is oxidized in the air, the heat disengaged is not sensible, but if they proceed quickly the disengagement of heat is very intense and we have then combustion.

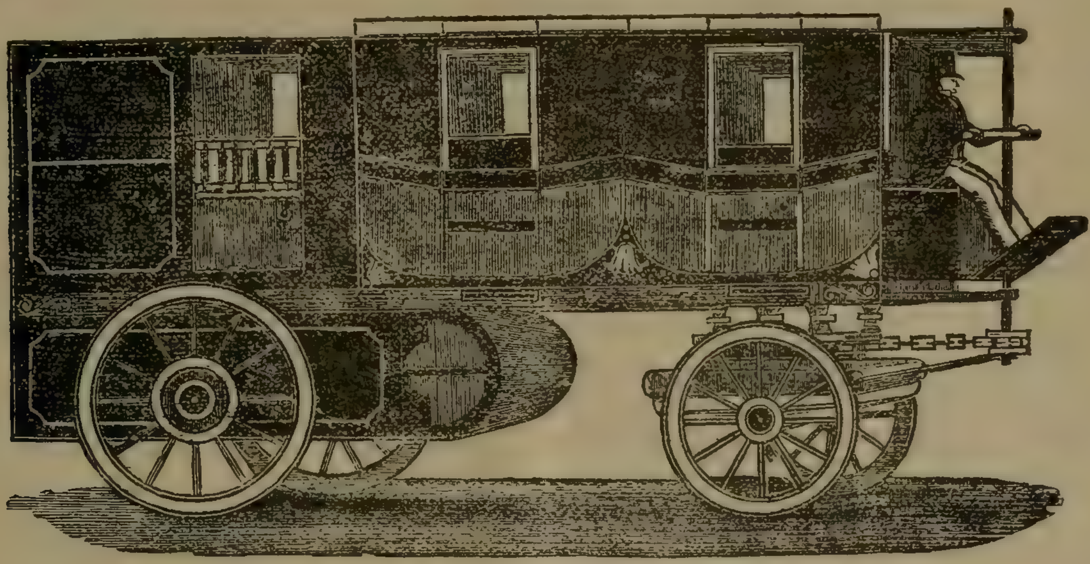
What we call combustion includes all chemical combinations in which there is a simultaneous disengagement of heat and light. In the combustion which we find in ordinary fire-boxes carbon and hydrogen combine with the oxygen of the air.

There are two kinds of combustion, the complete or total and incomplete or partial.

In complete or total combustion the carbon is transformed into carbonic acid and the hydrogen into water, and there is complete oxidation.

In partial combustion we simply transform the carbon into carbonic oxide. We decompose water and the ternary compounds of certain combustibles into a mixture of hydrogen, more or less carburetted, and of carbonic oxide.

In this way we obtain gases which are very combustible and which in their turn serve for the production of heat. The apparatus in which this transformation is effected are called gas generators, and the operation itself gasification of solid or liquid combustibles. We use this process whenever a gaseous fuel is more useful or more convenient than the ordinary fuel.



HANCOCK'S STEAM CARRIAGE.

*Reprinted from the* Railroad Journal *of November* 17, 1832.

There are nevertheless combustions in which oxygen has no part. For instance, if we place antimony in a finely divided state in a flask filled with chlorine, it will unite with the chlorine with an active production of heat and light and will form chloride of antimony.

A combustible in the ordinary acceptation of the term is a combination of carbon which may be solid, liquid, or gaseous, and which when combined with oxygen, produces the phenomenon of heat.

Generally speaking, the development of heat is accompanied by flame, because the substance produced by the combustion is gaseous ; such is the case with coal.

Combustion, however, is not necessarily accompanied by flame or even by a setting free of heat. For instance, magnesium burns with a considerable disengagement of heat or light but without flame, because the product of combustion is not a gaseous body but a solid one, oxide of magnesium. In the same way iron in a very finely divided state plunged in oxygen produces also the phenomena of heat and of light, but without flame, because the result of combustion is oxide of iron.

If the same iron in a lump is exposed to a moist atmosphere it will not burn, but it will be gradually converted into oxide as in the first case. Here we have combustion without the phenomena of heat and light, but nevertheless if we consider the case carefully we will see that heat is produced and that this quantity of heat is precisely equal to that obtained more rapidly when the iron is exposed to oxygen in the condition of fine powder ; but in the second case the heat is developed very slowly and is dispersed as soon as produced, while in the first the rapidity of production is greater than that of dispersion, and the heat developed serves to make the mass red-hot and to produce the phenomenon of light.

Combustibles or fuels are divided into three classes :

1. Solid fuels, which are the most numerous and the most generally employed.
2. Liquid fuels.
3. Gaseous fuels.

We distinguish also natural and artificial fuels. Natural fuels are those which are found already in nature, such as vegetable fuels, like wood or turf, and mineral fuels, like lignite, coal, and anthracite or hard coal. These mineral fuels have a vegetable origin, and their composition is generally nearer to that of wood or turf, as the strata in which they are embedded are of more or less recent origin.

The combustion which is most used is that which results from carbon in the state of coal. In most cases it is found in considerable quantities, and the price is generally lower than that of any other fuel.

The combustion of coal is, then, that which we must consider in order to see how it proceeds when it is used to make steam through the medium of an ordinary grate, and to ascertain what is the best and most economical method of using it.

### II.—THE COMPOSITION OF COAL.

As coals of all sorts may be used to burn in fire-boxes of steam boilers, it is of considerable importance to know their composition and the manner in which they behave in the fire. The best classification seems to be that adopted by Grüner in his study on the Coal Basins of the Loire. He divides them into five types, according to the nature and proportion of the fixed carbon, following rather the analysis by distillation than the ordinary elementary analysis. These five classes are as follows :

1. Dry coals with long flame. These have from 75 to 80 parts of carbon, and will furnish from 50 to 59 per cent. of carbon in rapid combustion.

2. Oily coals with long flame, or gas coals. These have from 80 to 85 parts of carbon, and will furnish from 59 to 67 per cent. of their weight in carbon for rapid consumption.

3. Ordinary soft coals or forge coals. These have from 84 to 89 parts of carbon in composition, and will furnish from 67 to 74 per cent. in the fire.

4. Soft coals with short flame or coking coals. These have from 88 to 91 parts of carbon in composition, and will furnish from 74 to 82 per cent. in the fire-box.

5. Hard coal or anthracite, having from 90 to 93 parts of carbon and furnishing from 82 to 90 per cent. of carbon in the fire.

It will be seen that the proportion of fixed carbon varies from 50 to 90 per cent., and the elementary composition varies between the following extreme limits: Carbon, 75 to 93 parts; hydrogen, 6 to 4; oxygen, 19 to 3.

In general, it may be said that the heating power of coal increases in ratio to the amount of carbon. In other words, it is in direct proportion to the carbon which is disengaged in distillation. The more oxygen the coal contains, the more its heating power diminishes. Anthracite coal, for instance, has a very high heating power, but it is lighted with difficulty, and sometimes requires special apparatus for starting the fire and for draft. These coals burn well only when broken up within certain limits of size, and ordinary draft is not usually sufficient, forced draft or high chimney stacks being necessary. It burns without smoke with a short flame, and the fire is usually of an intense and very bright red.

The softer coals generally contain a quantity of carbon in the gaseous state in combination with hydrogen. Solid carbon in assuming a gaseous form requires sensible heat and latent heat, as water does when it is transformed into steam. The latent heat already exists in the gaseous carbon which is contained in coal, and there is no need to furnish this in the fire-box. This explains the superiority of soft coals with a short flame, and in general the coals containing little oxygen. They have the property of developing intense heat in the fire-box, and are much desired for use as steam coals. Their value depends on the state of cohesion and also to some extent on the coking power —that is, the extent to which the coal will fuse and run together under the action of a high degree of heat.

In general coal has less coking power, as it includes a larger proportion of oxygen, and greater coking power as the proportion of hydrogen is relatively increased. Its value also is less, other things being equal, as the proportion of cinder is greater. The richer a coal is in carbon the greater usually is its density. Something, therefore, will be indicated by the weight as to its value as a combustible.

We have already stated that carburets increase the heating power of the coal very considerable by reason of the free carbon which they contain. We are not surprised then to find that we obtain a high heating power with coal containing earthy matters, provided they are rich in what we may call coal-tar. However, there are certain results which we have tried in vain to explain. For instance, we may take two coals having the same elementary composition, but which give entirely different results in combustion; the most simple and only reliable way is to try them in the fire-box before judging of their value.

The cinder resulting from the combustion of coal has during its period of formation inconveniences more or less serious, depending on the nature of the coal and the composition of the cinder itself. If the coal is soft or oily, that is to say, of a kind which develops a sufficiently intense heat, the cinders will melt and run together upon the grate, preventing air from passing through freely; the fire will be poor and it will become necessary to break up the cinder or slag.

Hard coals with little flame do not generally fuse the earthy matters mixed with them, and, on the other hand, they generally contain a very small proportion of gaseous carburets. The heat in the fire-box is less intense and is not sufficient to melt or fuse the cinders, and they will generally fall through the grate without clogging or closing it. Something, however, depends upon the composition of the cinders themselves. Generally they contain silica, alumina, lime, oxide of iron, etc., in variable proportions. Silica and alumina will not form a fusible compound. If the silica is mixed with lime, the cinders are apt to become caked, and when they contain iron they will melt and become more fusible as the proportion of the iron is greater; thus coal containing pyrites is especially troublesome and apt to block up the grates.

Cinders may be divided into fusible and infusible.

White or light colored cinder is generally infusible and separates from the fire in the state of fine powder. Colored cinders, especially those which contain iron and lime, are apt to melt or to run off without interfering with combustion. The most unfavorable case is that of cinders which may be called demi-fusible. It is this which cakes and fills up the cavities in the grate, assuming the form of slag, which is often very hard and difficult to break up.

The best results both in avoiding trouble with the cinder and in securing a good fire, is arrived at by using a composition of different coals. It often happens that the mixture of softer and harder coal gives better results than can be obtained with either one separately.

Most coal contains a greater or less proportion of sulphur, which is usually found in the state of iron pyrites. Too high a proportion of this injures a coal for combustion, because in the fire-box the sulphurous acid which is produced combines with steam and is transformed into sulphuric acid, which rapidly corrodes the iron or steel plates of the fire-box. This action is increased very much where there is a light leak, for instance, along the lines for rivets. Corrosion will then become very rapid and the boiler will degenerate quickly.*

### III.—HEAT RESULTING FROM THE COMBUSTION OF COAL.

The calorific power of a combustible is the amount of heat developed during its combustion by a unit of weight. It is the principal element in its industrial value which is counted in units of heat or *calorics*. The *caloric* represents the heat which a unit of weight of water absorbs when its temperature is increased 1° Centigrade.

When we say that a certain fuel has a calorific power of 8,000 *calorics*, we understand by that one kilogram of that fuel can raise the temperature of 8,000 kg. of water 1°; it being understood that the combustion is complete, and that the heat developed has been applied entirely to heating the water.

A large number of careful experiments recently made at Mülhouse have showed that the heat of combustion of coal is very variable and cannot be predicted beforehand, sometimes being greater than the calculated amount, sometimes falling below. It can only be said that the heat developed by combustion is almost always greater than that calculated by the old formulas, and often greater than that theoretically due to the combustion of the total carbon and hydrogen contained. The only method, therefore, to correctly ascertain the heat developed is to burn it in a calorimeter.

M. Cornut, who has made many experiments, has proposed that we consider the carbon as divided into two parts: one fixed, which forms coke, and the other volatile, which is disengaged when coal is distilled. Many other formulas and methods have been proposed, but without proceeding into a complete analysis of all of them, we may say that so far it has not been possible to draw any theoretical conclusion from a comparison of results obtained in the calorimeter with those furnished by the formulas; and that the conclusions based upon the chemical composition of coal seem to be unreliable. All that we can say is that the more hydrogen a coal contains and the more water is formed in burning, the greater the difference between the figures.†

### IV.—THE GRATE.

The surface of the grate must be in proportion with the quantity of coal to be burned. When it is too small it

* A number of tables which are given in the original paper show the composition of different coals, and are not repeated here, since they relate entirely to the product of different local mines and have no application here.

† The theoretical portions of this section of the article has been considerably condensed, for the reason that most of the formulas given relate especially to coals of local production and might not be applicable in this country.

will be necessary to clean up the fire frequently; if it is too large, the layer of fuel becomes too thin, and part of the air will pass directly through the fire and will have the effect of cooling off the boiler. Moreover, the fire will be uneven and the combustion will vary at different points.

The grate surface varies also with the kind of boiler and more especially with the kind of coal.

For natural draft there is usually a consumption varying between 0.50 and 1 kg. About 0.75 kg. per hour and per square decimeter of grate surface is the average figure which applies very well to ordinary soft coals. For coke, turf, or wood the figures will vary. The consumption of coke will vary between 1 and 2 kg. per square decimeter of grate surface per hour, according to the intensity of the draft. In marine boilers, where forced draft is used, the consumption varies from 2 to 2½ kg., and in locomotives, where the draft varies from 25 to 75 mm. pressure, the consumption will vary between 2 and 3½ kgs.

The grate-bars should be narrow and placed close together in order to permit the passage of as much air as possible and to distribute it regularly through the fuel. The finer the coal employed the closer the bars should be. The dimensions most generally adopted for ordinary coal, well broken up, is to make the bars from 12 to 15 mm. wide with spaces of from 5 to 7 mm. between. Their depth at the center should be from 100 to 150 mm. and at the end 60 mm. In this way we obtain as complete a division as possible of the air used in combustion, the grate-bars are less exposed to being burned and will last longer. For wood and for lump coal which does not break up much, the interval between the bars can be increased to 10 or 12 mm., and the thickness of the bars themselves to 25 mm. In some places grates are used of flat bars of iron, $1 \times 8$ mm. in section, riveted to cross-bars in such a way as to leave an opening equal to the width of the bar. With this system coal of any size can be burned without losses by sifting through.

A length of 1.80 m. should not be passed; beyond that the maintenance of the fire become difficult and hard for the fireman.* Some engineers do not wish to go beyond 1.60 m. and prefer to make the grate wider in order to obtain the necessary surface. In exceptional cases the grate is made as much as 2.20 m. in length, but in such cases it is necessary to put in additional bearers, so that the grate-bars will not be too long.

In boilers furnished with re-heaters or combustion chambers these large grates have the advantage of being favorable for a strong draft, for then there is sufficient surface to absorb the heat generated.

The width of the grate must be determined by the size of the boilers.

The grate should be from 0.30 to 0.55 m. from the nearest point of the heating surface, according to the size of the boiler, in order to prevent the cooling or breaking up of the flame by too direct contact with the heating surface. When the distance of the fire-box from the boiler is too great, the gases rising vertically are not well mixed and the radiating effect is diminished.

At the end of the grate-bars some play should be left to admit of their expansion. This is 0.0012 at the temperature of 100°, or at 500° it would be 0.006.

Grates are generally placed horizontally, but where exterior fire-boxes are used an inclination varying from 1 in 8 to 1 in 10 toward the back end is frequently given, and the same practice is sometimes followed in locomotives. This arrangement has the advantage of leaving more space for the development of the flame without decreasing the opening for ashes and of giving more space for the entrance of air.

The height of the grate in a stationary boiler should be such as to admit of the easiest work in making up the fire and in cleaning out, in order to make the work of the firemen as light as possible.

A grate of 2 sq. m. surface should be considered as a maximum which we ought not to pass in practice. If a larger surface is needed, it is better to employ several fire-boxes and several grates.

* This length (about 6 ft.) is often passed in this country, especially in locomotive boilers where anthracite coal is burned and where in some cases the fire-box is from 10 to 14 ft. in length. It does not follow, however, that such long fire-boxes are advisable.

Soft coal burning with a long flame and rich in hydrogen needs a longer grate and one placed at greater distance from the heating surface. Inclined grates, where the fire is fed automatically either by hoppers or by a screw device which deposits the coal upon the grate, have the great defect that the distance of the fire from the heating surface is increased, this diminishing the important action of direct radiation. Such devices can only be economical in a few special cases, and their general use is not advised.

### V.—TO CALCULATE THE DIMENSIONS OF A GRATE.

If we assume $s =$ the grate surface desired; $p =$ the weight of fuel burned per square meter per hour; and $N =$ the calorific power of the fuel, the weight of the fuel burned per hour will be $p\ s$, and, if the combustion is complete, the heat disengaged will be $p\ s\ N$.

But the heat actually utilized is much less, owing to incomplete combustion, cooling of the fire-box and the disengagement of gases of combustion at a high temperature; it follows, therefore, that we can utilize only a fraction of the theoretical total heat. This fraction we can call the resultant, and indicate it by $r$; in practice it varies from 0.50 to 0.80.

If, then, we have to produce a quantity of heat represented by $X$, we will have:

$$X = r\ p\ s\ N.$$

Suppose that we have to produce 1,000 kg. of steam per hour. The number of *calorics*, or units of heat, necessary to vaporize to a temperature of $t°$ one kilogram of water taken at $t'°$ is given by the formula

$$n = 606.5 + 0.305\ t - t'.$$

For steam at a pressure of 5 atmospheres, $t = 152°$.* If the temperature of the feed water is 12°, we have,

$$n = 606.5 + 0.305 \times 152 - 12 = 640.86,$$

and therefore,

$$X = 1000 \times 640.86 = 640,860 \textit{ calorics}.$$

If we assume a resultant $r = 0.60$, and if we use a coal having a heating power $N = 7000$ *calorics*, we will have:

$$640,860 = 0.60 \times p\ s \times 7000$$

$$p\ s = 152.5.$$

If we assume $p = 75$ kg., then

$$s = \frac{152.5}{75} = 2.03 \text{ sq. meters.}$$

This gives us the grate surface desired. If we make the length of the grate 1.80 m., the width will, of course, be $2.03 \div 1.80 = 1.12$ m.

### VI.—THE ASH-PAN.

The ash-pan or ash-box is the space below the grate into which the ashes and cinders should fall. It is important that it should have such a depth that the hot ashes and burning cinders which fall into it will not radiate too much heat on the lower side of the grate. If the depth is not sufficient the grate-bars will be between two fires, and be quickly destroyed, so that frequent renewal will be required. A very common practice is to place in the bottom of the ash-box a cast-iron pan which is filled with water. The object of this is to extinguish and cool the cinders which fall from the grate and to prevent any injurious effect on the bars. Moreover, the surface of this pan of water has the advantage of showing the fireman the state of combustion on the grate by reflection. If the reflected light is irregular and there are black patches, it shows that the combustion is imperfect in corresponding parts of the grate, and the fireman should look carefully at his fire in order to level off the bed of coal.

The ash-box must be provided with doors conveniently arranged, which can be shut when necessary. These

* The temperatures here given are on the Centigrade scale. Reducing them, 152° Cent.=305.6° Fahrenheit, and 12° Cent.=53.6° Fahr.

doors serve, with the damper, to prevent too great a circulation of air in the boiler when the fire is damped down for the night, for instance, or when it is not in active use, and will keep the fire in condition to come up quickly when it is again needed, thus effecting economy of both time and coal.

(TO BE CONTINUED.)

## THE MEXICAN CENTRAL COMPOUND LOCOMOTIVE.

THE accompanying cut shows the general appearance of the compound locomotive with which the trials on the Mexican Central Railroad were made, as described by Mr. F. W. Johnstone, the Superintendent of Motive Power, in the June number of the JOURNAL. As then stated, the engine was of the consolidation type, with 20 × 24 in. cylinders and 50 in. drivers. It was changed to a compound by putting in new cylinders, arranged on the plan devised by Mr. Johnstone, the high-pressure cylinder, 14 × 24 in., being inside and the low-pressure cylinder forming a ring outside it. As the best way of showing this arrangement, we reprint herewith the diagram, fig. 1, showing a section through the cylinders and steam-chest. The total diameter of the

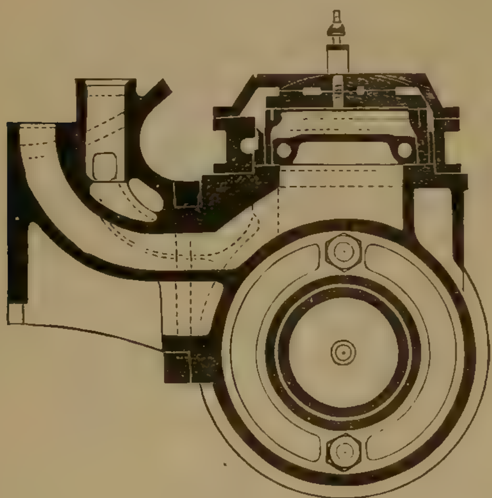


Fig. 1.

low-pressure cylinder is 30¾ in., its area, after deducting the space taken by the high-pressure, being equivalent to that of an ordinary cylinder 24½ × 24 in. The ratio between the two cylinders is 1 : 3.

The methods adopted in making the tests and the results obtained were fully described last month. These results were so good that the company has decided to change a number of its engines in the same way, and is having several new ones of the same pattern built.

## THE AVERAGE OBSERVER.

THE following article, which is sent by a contributor to the *English Mechanic*, though not strictly scientific, is very interesting, and will no doubt confirm the experience of many of our readers :

My general attitude of caution in all matters of average testimony secures for me so much misunderstanding, that it is quite refreshing to find my views shared by sounder judgments than my own.

The following record of a series of experiments made to test the reliability of "the average observer" may interest some of your readers, especially as I believe no such data are on record. I suppress the names of the participants, but they are at the disposal of any scientific reader who desires corroboration of my notes.

The circumstances which gave rise to the experiment were these : In January, 1882, a civil action was tried in the Queen's Bench. In it an important question turned on what really took place at a certain interview at which five persons were present. It was alleged by the plaintiff that on the occasion in question he entered a room carrying in his hand a sheet of foolscap rolled longitudinally ; that he laid it upon the table in the sight of all present, and that once during conversation he distinctly indicated it by a gesture. This story was corroborated in the main by two gentlemen, disinterested parties in the action, but was totally denied by two others, equally disinterested. The jury delivered the defendant's version.

These facts, and the discussion they excited among certain friends, induced me to carry out the following experiments one evening after dinner. I asserted the broad proposition that I should enter the room, remain an indefinite number of minutes, perform distinct actions, and make distinct remarks, and that in no case would all of the seven observers present agree in describing accurately, five minutes afterward, either in writing or orally, all that I did.

To insure accuracy, I drew up privately a detailed programme, describing exactly what I did do, and held it in my hand for reference. The conditions were that I should enter the room twice, performing a distinct set of actions each time, and that after an interval of five minutes from the conclusion of my second entrance, each person should describe in writing whichever of the two entries I indicated. There was to be no prompting, and no amending what was once written. A description of my first entry will give an idea of the character of the experiments.

Entered room, carrying book in right hand ; advanced toward table ; slightly moved chair ; sat down in it long enough to open book ; read aloud title-page ; remarked, "This is from Jones's collection ; I have the original edition, but the bindings are shabby ;" rose, carrying book ; walked to piano ; adjusted music on stand ; asked B. if he had heard Pinsuti's latest song ; laid book on piano-lid ; stood on hearthrug with back to fire ; made remark to C. ; looked at watch, and, retaining it in hand, left room, laying book on sideboard as I passed, and, in closing door, appeared to have difficulty in turning handle. Time occupied, 4½ minutes.

The second entry was a little more elaborate, the number of distinct actions being 13 ; time occupied, 6 minutes.

I selected entry No. 1 for description. Result : No one described all I did ; three omitted incident at piano ; two omitted remark made on hearthrug ; three blundered over order of procedure. None repeated accurately any one remark. In cross-examination, the results were yet more surprising. Here are a few questions I asked, with the number of correct replies : "In which hand was book ?"—three. "With which hand did I remove chair ?"—four. "On what portion of the piano-lid did I place book ?"—five. "With which hand did I open door ?"—four.

Eight other tests were made, and 36 questions were asked in cross-examination. To only three questions were the answers unanimous.

It may, of course, be objected that these were practically tests of memory, and to a large extent this is the case. But what is to be said for the following cases of distinct misperception ?

The answers to these questions were not given verbally, but written down. 1. "Where were my glasses ?" (*pince-nez* attached in usual way by cord). A. answered correctly. B. said, "In right hand ;" D., on nose ; E., did not notice ; F., uncertain—thought they were on ; G., certain they were held in left hand. They were in my watch-pocket.

Question 2. "How long was I in the room ?" A., about ten minutes ; B., not ten ; C., uncertain ; D., over ten ; E., about fifteen ; F., from five to ten ; G., uncertain—should say ten minutes ; actual time, 4½ minutes.

I may here remark that in only one case did any one estimate the duration of time within three minutes of exact period in any subsequent test.

Question 3. (Asked at conclusion of 8th entry.) "How many times had I passed within touching distance of a small table situate in corner opposite door ?" A., about five ; B., ditto ; C., three ; D., "almost every time ;"

E., could not say ; F., dubious—perhaps three ; G., four. I had carefully refrained from approaching within five feet of it. In order to insure certainty I placed a mark on the door. For my fourth and seventh entries I changed my dress coat for a black cutaway coat. Two ladies noticed it, but only one gentleman "fancied there was some change." Before 2d, 4th, and 7th entry I removed my watch chain—a large and prominent one. In answer to questions put at the end of the last entry, four admitted having noticed its absence, but no one could specify at which entry it was absent.

It must be admitted by all that the conditions under which these tests were made were unusually favorable for careful and accurate observation, for not only were all on the lookout, but they practically knew what to look for. If under such favorable circumstances the results were so diversified, as the appended analysis shows, what is likely to be the average of reliable results under conditions which are not abnormal ? In order to assist in estimating the value of the test, I give the profession or calling of each observer.

The number of distinct actions performed was 176, and in the following table of results I divide them thus : *a*, actions unobserved ; *b*, actions misdescribed—*i.e.*, so inaccurate as to convey an erroneous impression of the act ; *c*, actions misplaced in order of sequence ; *d*. actions which were not remembered or not noted with sufficient clearness to be recorded :

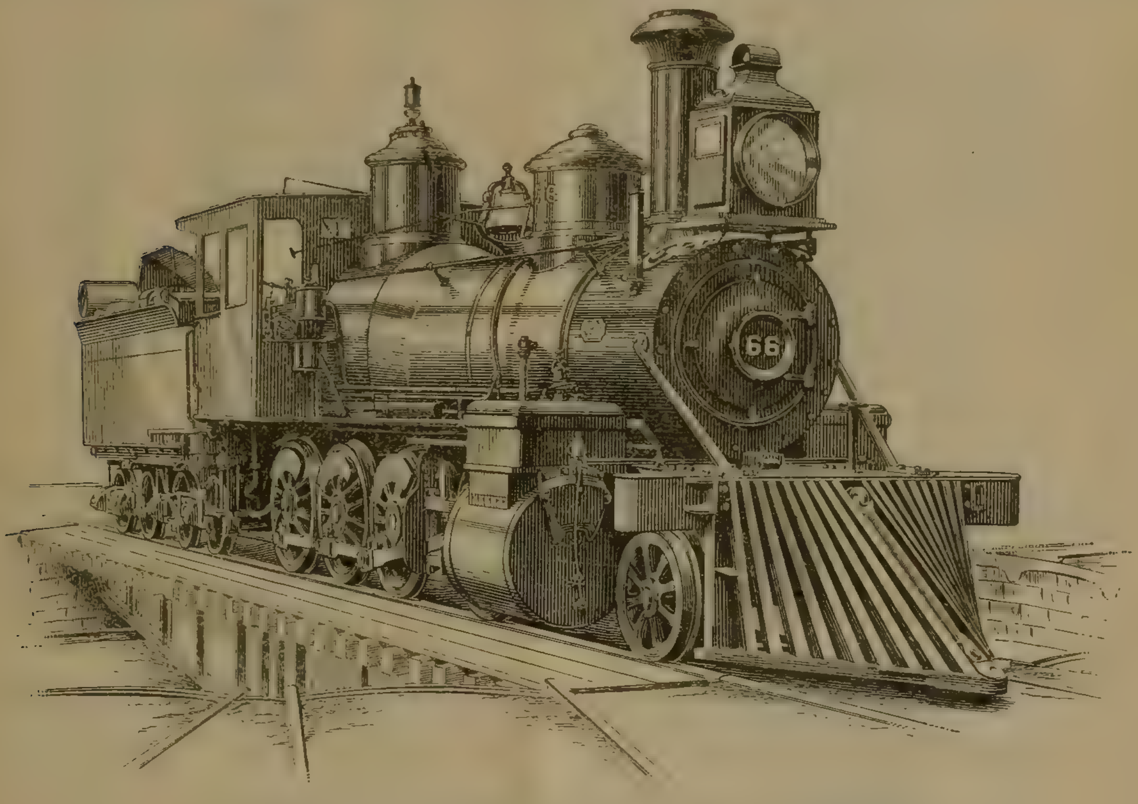
| | | | | | |
|---|---|---|---|---|---|
| Land Surveyor | *a* 3, | *b*. 4, | *c*. 1, | *d*. 5 | —Total 13 |
| Stockbroker | *a*. 5, | *b*. 5, | *c*. 3, | *d*. 5 | —Total 18 |
| Newspaper Editor | *a*. 2, | *b*. 5, | *c*. 11, | *d*. 7 | —Total 25 |
| Organist | *a*. 6, | *b*. 7, | *c*. 4, | *d*. 10 | —Total 27 |
| Commercial Man | *a*. 5, | *b*. 9, | *c*. 3, | *d*. 11 | —Total 28 |
| Solicitor | *a*. 3, | *b*. 3, | *c*. 3, | *d*. 23 | —Total 32 |
| Bank Clerk | *a*. 8, | *b*. 7, | *c*. 1, | *d*. 17 | —Total 33 |

An analysis of this list might be interesting if taken in relation to the professional training of the percipients. But for his excessive caution, the solicitor would probably have led the list. With the exception of the bank clerk all the observers were men over 30, and all appeared genuinely interested in the experiments.

A feature which struck me greatly was the proneness of the observers to connect an action in the later series with some analogous action witnessed earlier in the evening. No one was free from this blunder. The sole misperception in the continuity of actions of which the bank clerk and surveyor were guilty were in this direction. The latter connected an act in the 8th entry with one in the 3d ; the former connected the 1st and 5th entries. The large number of misses under the head of uncertainties is explainable by the anxiety of the observers to approximate a judicial frame of mind, as our legal friend put it.

I may add that the figure in class *b* in the bank clerk's score is indistinct in my notes. It may be 9, but I give him the benefit of the doubt.

Two ladies were present, but I kept no record of their observations. The little they did confirmed the popular tradition that ladies have keen eyes for detail. Both noticed every change in my appearance.




COMPOUND LOCOMOTIVE, MEXICAN CENTRAL RAILWAY.

DESIGNED BY F. W. JOHNSTONE, SUPERINTENDENT MOTIVE POWER.

## A LIGHTSHIP WITH ELECTRIC LIGHTS.

THE United States Lighthouse Board has recently invited bids for four new lightships of a greatly improved pattern. The accompanying illustrations show one of these ships, No. 51, which is to be stationed at Cornfield Point, Long Island Sound. Fig. 1 is a general view ; fig. 2, a longitudinal section ; fig. 3, a deck plan ; figs. 4 and 5, cross-sections ; fig. 6, a view of the light platform. The description herewith is condensed from the specifications.

The general dimensions are : Length over all, 118 ft. 10 in. ; length from inside of rudder-post to inside of stem, 110 ft. ; beam, molded, 26 ft. 6 in. ; depth of hold, from top of beam to top of keel, 14 ft. 6 in. In addition to the sails carried on the light masts, the ship will be provided with a propeller and steam power, which will not only enable her to return to her post if carried away by a gale,

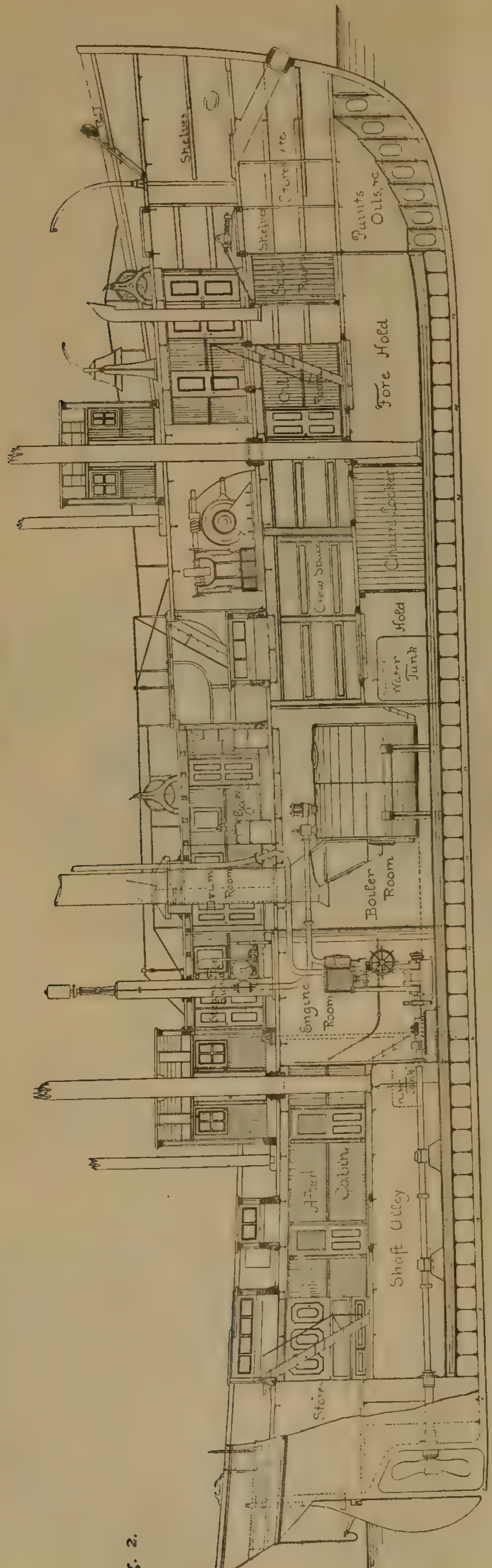



Fig. 2.

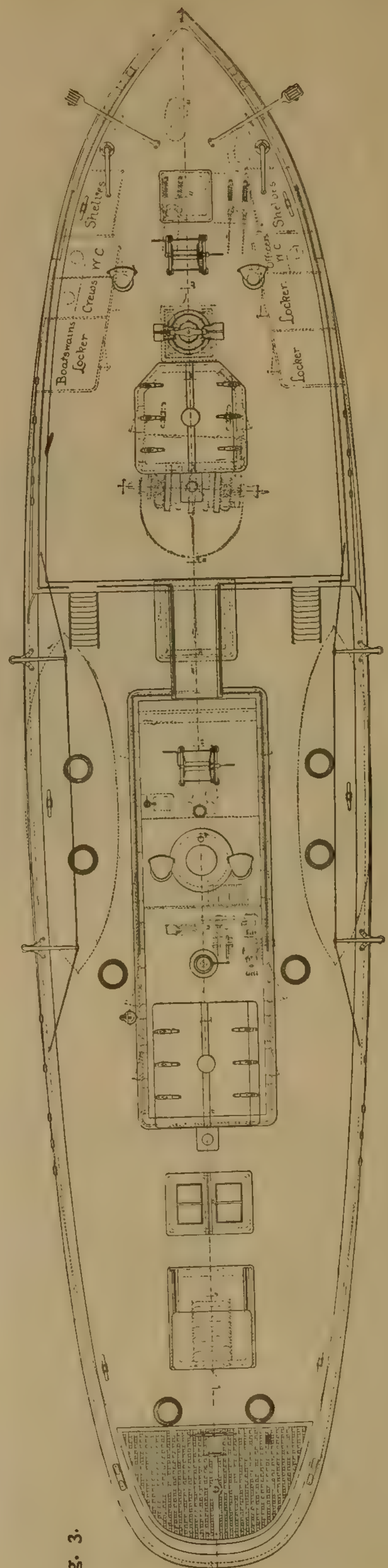



Fig. 3.

PLANS FOR LIGHTSHIP NO. 51, FOR U. S. LIGHTHOUSE BOARD.

but will also be of much assistance in keeping her in place, as they can be run during a storm, and thus diminish the great strain on the cables.

The hull will be built entirely of iron, strongly framed and braced. There will be four main bulkheads extending up to the main deck, built thoroughly water-tight. The vessels will have a bar-keel and a sternpost forged solid with the rudderpost, and arranged for propeller shaft in the usual way, and as shown on plans. All plates in the shell of the vessels, the bulkheads, bulwarks, etc., are to be machine planed, and no other method of fairing the strakes or preparing edges for calking will be allowed. The plating will be run in inside and outside strakes, perfectly fair, and smoothly fitted up and riveted. The vessels will be provided with one outside bilge-keel on each

leads, scuppers, two hard wood stairs leading to the forecastle deck, and all other fittings for all purposes required by the service. The vessel will be rigged with two masts and trysail-masts arranged as shown on plans.

The cabin and crew-space will be heated throughout by steam, well ventilated and fitted with all necessary conveniences and arrangements for comfort. The fittings required for her special service will include one mushroom anchor of approved pattern, weighing 5,000 lbs.; one bower anchor, weighing 2,500 lbs.; one harbor anchor, weighing 2,000 lbs.; two 2-in stud-link bower chains, 120 fathoms each; one 1½-in. stud-link mooring chain, 120 fathoms; one 2-in. stud-link spare chain, 15 fathoms; also a bell of 1,000 lbs. weight, mounted in an iron frame.

The masts are to be 67 ft. in length. The rigging will

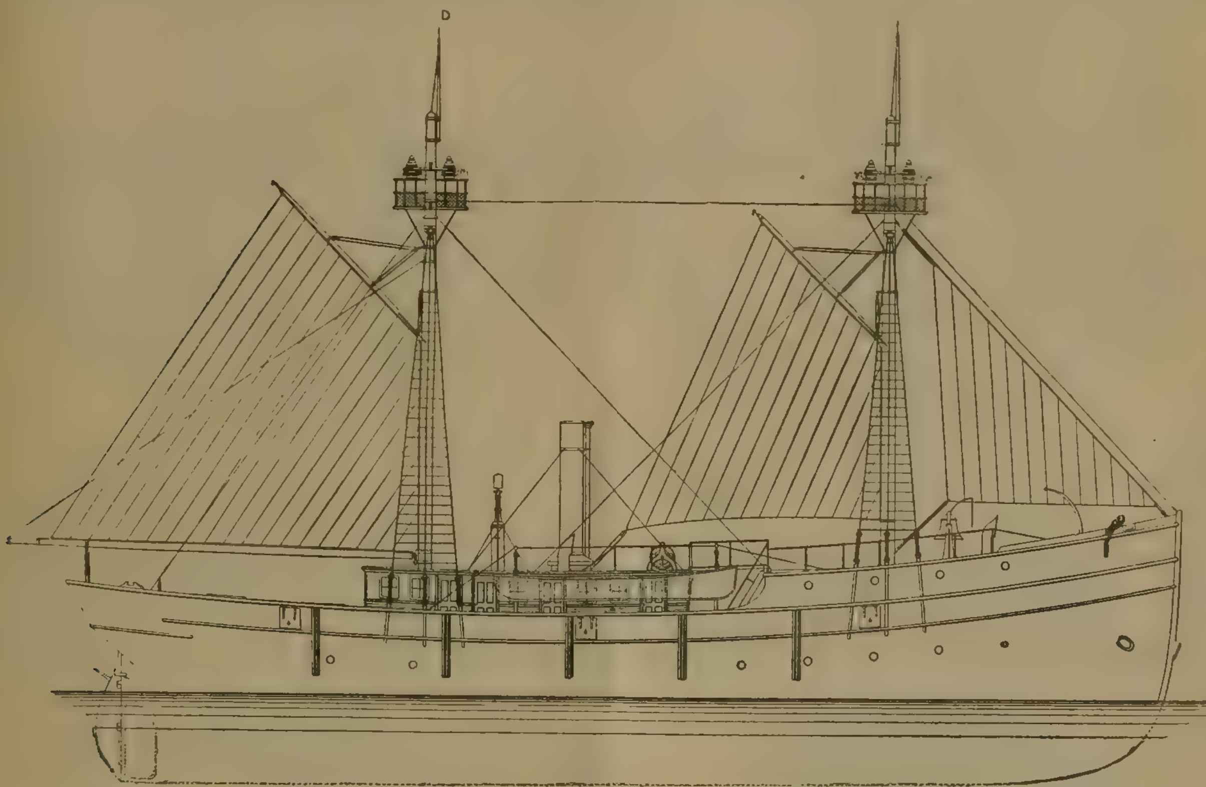



Fig. 1.

LIGHTSHIP NO. 51, FOR U. S. LIGHTHOUSE SERVICE.

side of the vessel, extending for about 55 ft., constructed as shown on plans, and the run of these keels shall conform with the natural run of the water when the vessel is in motion.

Under the main deck, commencing aft, will be located storeroom, cabin, with four staterooms, coal bunkers, engine and boiler-room, crew space with 10 berths, lockers, wardrobes, tables, etc., pantry, oil-room, sail-room, and the forepeak will be fitted up as a storeroom with necessary lockers and shelves. Under lower deck, forward, will be located water-tanks, chain lockers, forehold, and a storeroom for paint, oil, etc. On the main deck aft will be placed steering gear, skylight, and companionway for cabin, and the main-deck house will extend from about frame No. 17 to about frame No. 35, consisting of lantern-room, pump, and fog-whistle machinery-room, and galley. Forward of this house, and under the forecastle deck, will be located a steam windlass with elastic chain stoppers, lockers, and water-closets for officers and crew, as shown on plans. On the forecastle deck will be located a lantern-house, hoisting engine, bell, etc., and on top of the main-deck house will be placed a steam fog-whistle and a hoisting engine; both the top of the deck house and the forecastle deck will be surrounded by a strong and neatly built iron railing. On the main deck will also be located two boats, necessary ringbolts, bitts, chocks, fair-

be of wire rope, and the sails arranged as shown in fig. 1. A lightning conductor will be carried on each mast.

There will be one right-handed, two-bladed, cast-iron screw-propeller of about 6 ft. diameter and suitable pitch, driven by an inverted non-condensing single-cylinder engine, the cylinder to be 17 in. in diameter and a stroke of 17 in. The propeller shaft will be 5 in. in diameter.

There will be two cylindrical single-ended steel boilers of the Scotch type, 8 ft. in diameter and 9 ft. long, provided with corrugated furnace, 36 in. diameter, in each boiler. There is to be furnished and fitted in place one horizontal, non-condensing engine, about 5 in. diameter of cylinder and 6 in. stroke, with properly attached machinery for operating the steam whistle; also one Baird's No. 3 distilling apparatus, with necessary evaporator, filter, pumps, etc., all to be arranged as shown on plans, and as will hereinafter be described and specified. The steam whistle will be 12 in. diameter of bell.

Lightship No. 51 will be the first one in the United States provided with electric light. For this purpose there will be two engines, which must be horizontal high-speed engines, with automatic cut-off governor; to be capable of developing 8 H. P. at normal speed, with 70 lbs. steam, cutting off at one-quarter stroke; governor to control speed accurately, and to be capable of adjustment to enable speed to be varied 20 per cent. above or below the normal.

Two pulleys, 32 to 36 in. diameter, with 5-in. flat face, will be required with each engine.

Engines will have no outboard bearing, and will have cast-iron base complete, ready to set on deck at floor level.

The dynamos are to be compound wound, and are to be of at least 60 amperes capacity, with an electro-motive force of about 110 volts at terminals of machine; they are to be automatically regulated, so that three-fourths of the lamps may be extinguished with safety without material change of speed. They must not spark, and must not require the brushes to be shifted to accommodate change of load. Their commercial efficiency must be at least 80 per cent. An Evans friction cone of the proper size to transmit the full power of the engine is to be furnished with each dynamo.

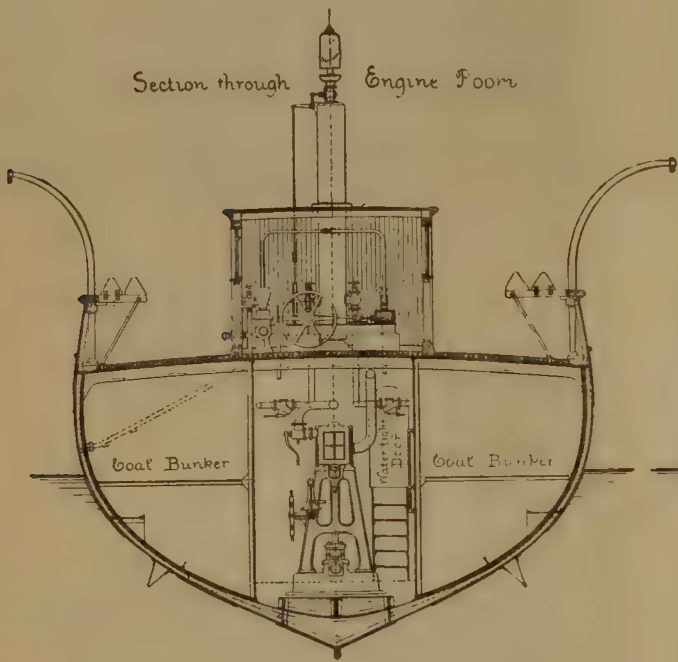



Fig. 4.

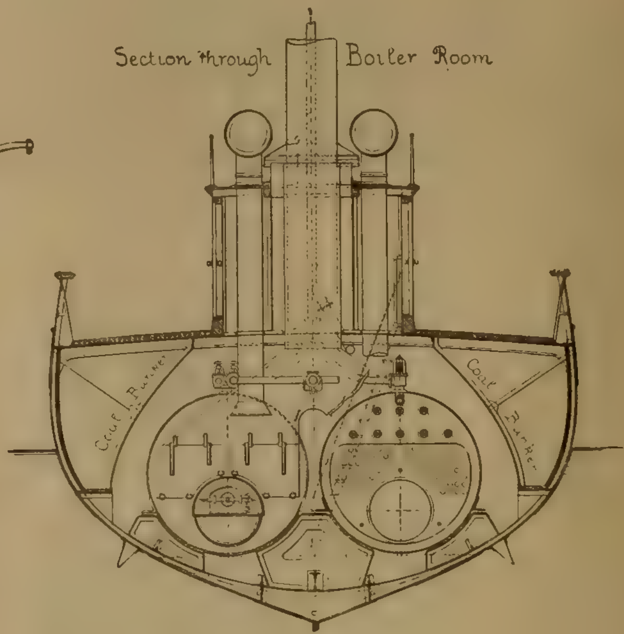



Fig. 5.

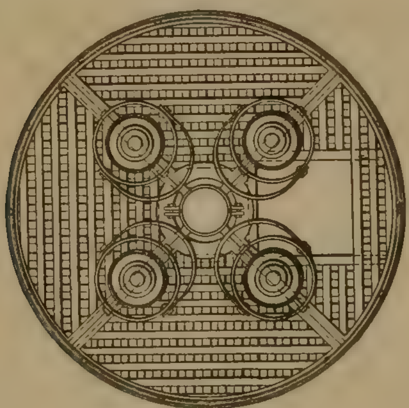


Fig. 6.

The engines and dynamos are to be so located that, with the Evans friction cones, either engine can run either or both dynamos. The dynamos will therefore be furnished with sliding bed-plates, so that they can quickly be thrown in or out of action.

The actual floor space occupied by the dynamos and engines must not exceed $8\frac{1}{2} \times 11$ ft.

Attached to the engines or dynamos must be a device for alternately opening and closing, at regular intervals, the circuits to the lights at the mastheads; this device must be so made that the lengths of the intervals may be varied from 5 seconds to 20 seconds at will.

Eight 100 candle-power lamps with keyless sockets are to be furnished; the carbons of these lamps are to be coiled in a spiral according to the sample which will be supplied to the contractor.

Twenty 16 candle-power lamps, with key sockets, brackets, shades, and shade-holders, safety strips, are to be furnished and placed in position in the light-vessel where it may be directed. All lamps must last at least 600 lamp hours, must be interchangeable in their sockets, and each lamp must be marked with its candle-power and resistance when cold, and must not vary in resistance more than one ohm from a given standard.

The double wire system of conductors will be used, with proper insulation everywhere. The special system of engines and dynamos to be used is not named in the specifications.

Lightships No. 52, 53, and 54 are to be built at the same time, and will be in all respects the same as No. 51, except that they will not be provided with electric lights, but with lanterns of the usual pattern. They are to be stationed respectively at Fenwick Island Shoal, off the New Jersey coast; Frying Pan Shoal, off Cape Fear; and Martin's Industry, off the Georgia coast.

These four vessels will be probably the finest and most complete ships of their class ever built and put in service.

## THE UNITED STATES NAVY.

THE new Naval Torpedo Board consists of Commander Converse, Lieutenants Drake and McLean. Their first work will be the testing of the Whitehead and the Howell automobile torpedoes ordered for the navy.

### NAVY YARD EQUIPMENT.

In Washington, July 1, in the Bureau of Yards and Docks of the Navy Department, bids were opened for two 40-ton traveling cranes, to be erected, one each at the New York and Norfolk Navy Yards for handling heavy armor plates and placing them in position on the sides and turrets of ships. The bids were as follows:

Yale & Towne Manufacturing Company of Stamford, Conn., for both cranes, $92,200; for the New York crane, $47,100; for the Norfolk crane, $47,400.

Morgan Engineering Company of Alliance, O. for both, $79,966.25 ; for either crane separately, $45,093.75.

Southwark Foundry and Machine Company of Philadelphia, for both, $71,522 ; for one, $37,036.

Weimer Machine Works Company, Lebanon, Pa., for both, $104,300 ; for the New York crane, $52,500 ; for the Norfolk crane, $53,000.

American Ship Windlass Company of Providence, R. I., for both, $77,708 ; for the New York crane, $38,579 ; for the Norfolk crane, $39,189.

William Sellers & Company, Philadelphia, for both, $55,465 ; for the New York crane, $28,960 ; for the Norfolk crane, $29,000.

The Yale & Towne Company, the Morgan Engineering Company, and William Sellers & Company each bid on their own modification of the specifications prepared by the Department. The other bids were all on the Department specifications. The contract was awarded to William Sellers & Company, who agree to have the cranes completed in six months.

REVOLVING CANNON.

A 37-mm. Hotchkiss revolving cannon has been ordered for the Marine School of Application in Washington. The limber of this gun carries 300 rounds of ammunition, and the supply is supplemented by 1,000 rounds carried in an ammunition wagon.

It may be mentioned also that batteries of 6-pdr. Hotchkiss guns have been ordered for the revenue cutters *Corwin*, *Colfax*, and *Bear*. Other revenue vessels will also be supplied with these guns as soon as possible.

## THE GARRUCHA ROPE TRAMWAY.

(From *Industries*.)

At the important iron ore mines in the Garrucha District in the south of Spain, a rope tramway, or aerial ropeway, is used to convey the ore from the mines near the village of Serena to the shore of the Mediterranean, for shipment at Garrucha. As this ropeway is, we believe, the most important aerial line that has yet been constructed, a description of it will no doubt be of interest to our readers.

The chief feature of this—the Otto—system of rope transport is the employment of *two fixed carrying ropes*,

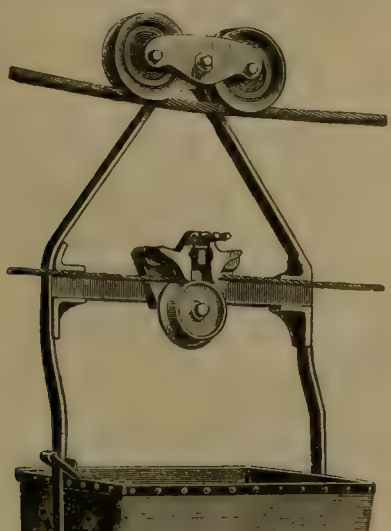


Fig. 1

along which the buckets are hauled by a light endless running rope. The advantages of using fixed ropes are, that it is possible to carry heavy loads, cross large spans, and surmount the steepest gradients with safety. Without this system of transport these rich mines would probably not have been opened out, as the cost of an ordinary railroad would have been very great, and more than absorbed all prospective profit on the sale of the ore.

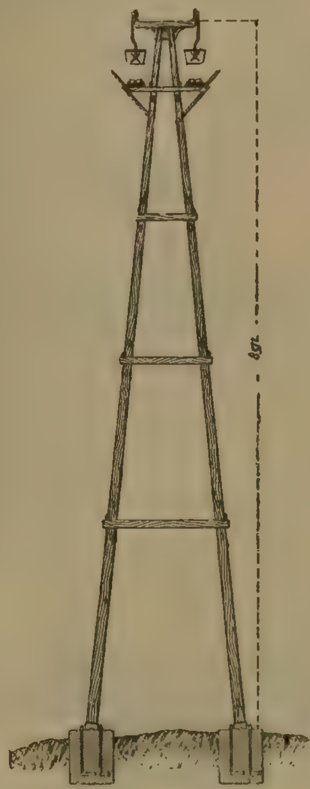


Fig. 2.

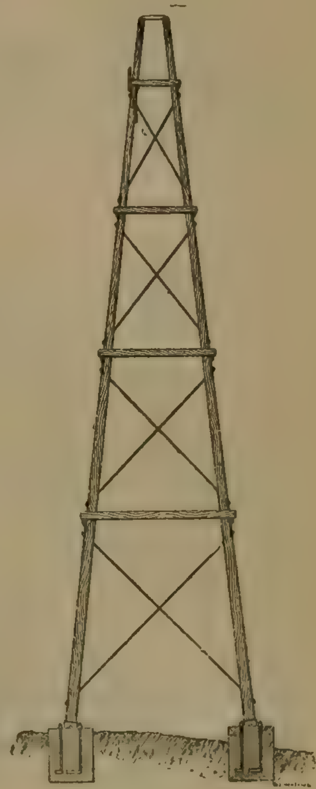


Fig. 3.

The standards for these lines are made either of wood or iron, and, according to their height and the strain they have to withstand, are either two or four legged. Figs. 2 and 3 show the design of a four-legged wooden support which is 85 ft. in height. The largest span on the line is

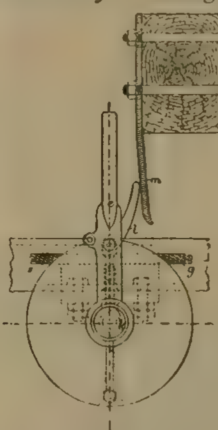


Fig. 4

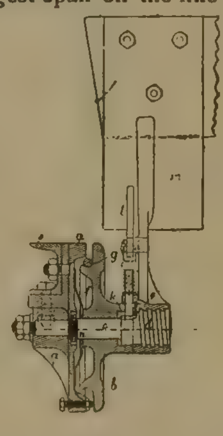
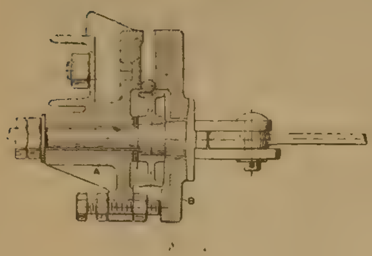


Fig. 6.

918 ft., and is situated near the Villa Reforma. At this point no less than six empty and six full buckets are suspended at one time between the supports. One of the standards on this line has a total height of 118 ft. The two-legged supports are held in position with guy rods. Fig. 1 shows clearly the relative positions of the fixed and hauling ropes, and fig. 2 shows how the carriers pass the supports.

These carriers consist mainly of four parts—a truck or runner, a triangular-shaped hanger, the bucket or skip, and the grip for attaching the carrier to the hauling rope. The form of buckets depends largely on the nature of the material to be transported ; for ore, coal, etc., a bucket

Fig. 7.



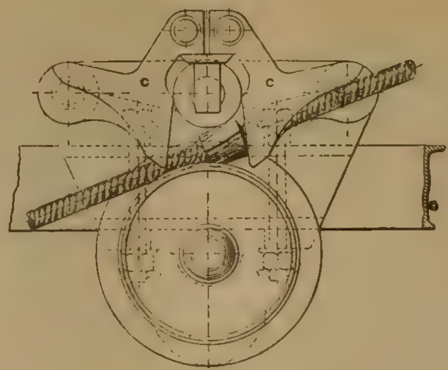


Fig. 9

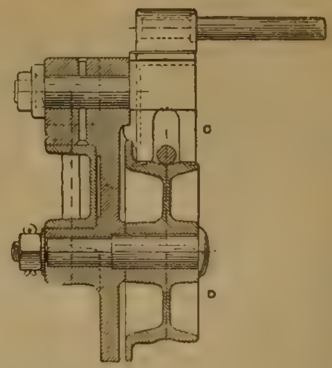


Fig. 10

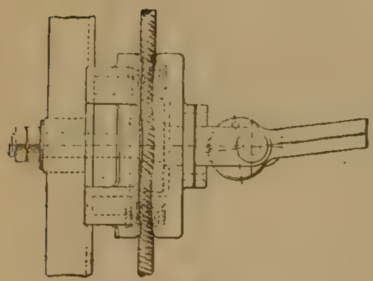


Fig. 8.

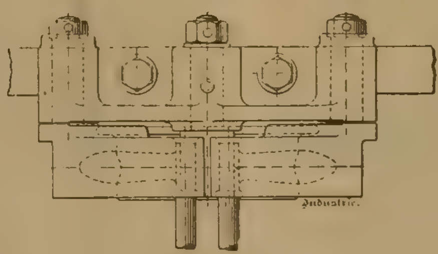


Fig. 11

Fig. 12

Fig. 13.

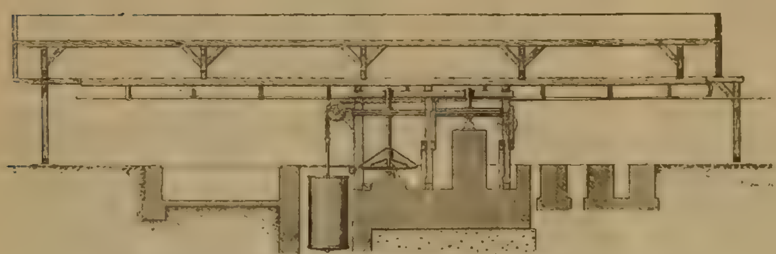


Fig. 14.—Longitudinal Section of Angle Station

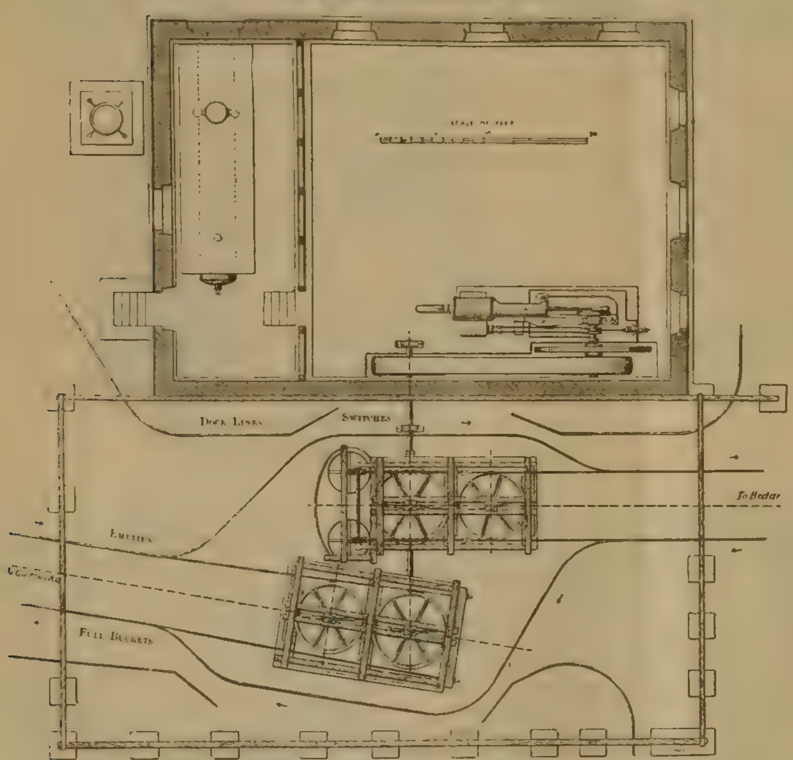



Fig. 15.—Sectional Plan of Angle Station.

arranged to be tipped by hand is usually employed, as illustrated in fig. 1. The buckets used on the Garrucha Line are of this form, and have a capacity of 784 lbs.

A most important detail, to insure regular and uninterrupted working of a line, is the form of grip that is adopted for attaching the buckets to the hauling rope. For lines with easy gradients friction grips are employed; these are of two kinds: the first, used for gradients up to 1 in 6, is shown in elevation and section in figs. 4 and 5, and consists of two smooth-faced disks, *a* and *b*, one rigidly attached to the cross-bar of the hanger, the other being free when out of action to revolve and act as a guide and supporting roller for the hauling rope. The spindle carrying the movable disk has a square thread on its outer end, and carries a lever, the boss of which forms the nut. If the lever is hanging down the disks do not grip the rope, and are kept apart by a spring. On raising the lever, however, through an angle of 180°, the disks are made to approach each other, and the hauling rope is tightly gripped between them. The lever is prevented from falling in transit by a small spring trigger. For gradients from 1 in 6 up to 1 in 3 a friction grip with corrugated jaws *A B* (figs. 7 and 8) has recently been employed, which differs from the disk friction grip above described, in that the movable plate or jaw *B* is corrugated and does not revolve, the pressure being obtained by means of a lever and eccentric, as clearly shown in the illustration. Both forms of grip work exceedingly well, and permit of the buckets being attached at any point of the hauling rope.

As on the Garrucha Line there are gradients of 1 in 2½, a friction grip would not be sufficiently reliable; it is necessary, therefore, to employ the pawl grip, shown in figs. 9, 10 and 11, representing a front

elevation, end sectional elevation, and general plan respectively. This consists of two symmetrically placed pawls *C C*, free to move in a vertical plane, with forked ends, which drop down on either side of the knots attached at intervals to the hauling rope. The hauling rope itself is carried on a roller *D* slightly below the pawls. To throw the pawls in and out of gear, pins are attached to their upper ends, and these at the stations come in contact with guide-rails which raise the pawls, automatically releasing the hauling rope and permitting the carrier to be switched off on to the shunt rails at the station. A large number of these grips, we are informed, are now at work, and in no instance have they been known to fail.

The latest and best form of knot, shown in figs. 12 and 13, has a star section, and has an outside diameter slightly in excess of that of the hauling rope. The strands of the hauling rope lie in the helical grooves as shown, the ribs forming the star projecting sufficiently above these to form a shoulder to press against the pawls of the carrier coupling. The knot is made fast to a steel wire strand *E* about 6 ft. long, which takes the place of the hempen core in the hauling rope; by this means it is rigidly held and any strain distributed, the strand forming the core being tightly gripped throughout its length by the strand of the hauling rope itself. The advantages of this form of knot are that it can be quickly attached to, and when worn removed from, the hauling rope without cutting the same; for fixing it is not necessary to employ white metal, which was found to very much impair the strength of the rope; moreover, the hauling rope does not lose its flexibility at the point of attachment, and any breakage of single wires is at once visible and easily repaired.

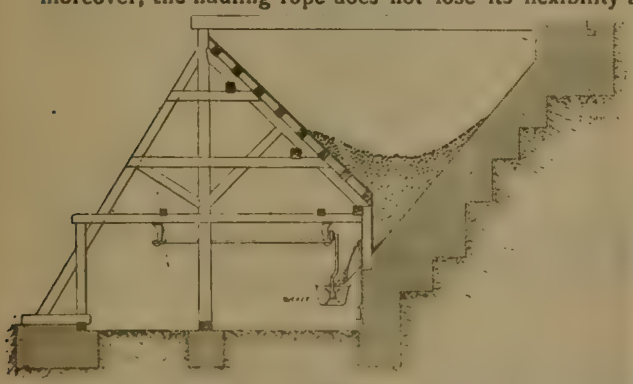


FIG. 18.

As these lines cannot be worked round curves, it is necessary, provided the ropeway cannot be carried in a straight line from end to end, to insert angle stations. Figs. 14, 15 and 16 represent a longitudinal section, a sectional plan, and a transverse section of one of these angle stations at Puerto del Coronel, the chief power station of the line. When the buckets arriving from Bedar reach the shunt rail at the angle station they are automatically disengaged from the hauling rope, as above described, switched on to the shunt rails, and run round by hand on to the carrying rope of the next section of the line, where they are again attached to the hauling rope and sent off in the direction of Garrucha. To avoid a violent impact of the knot and the coupling, the shunter gets a bell signal when a knot is approaching, and he pushes off the bucket at about the same rate as the hauling rope is traveling. If the line is not required to work at its full capacity the empty buckets can be docked at the stations, sidings being provided on to which the buckets are shunted out of the way.

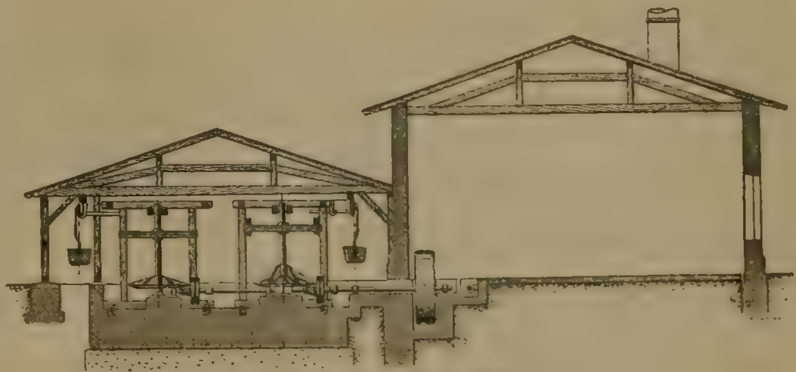


FIG 16.—TRANSVERSE SECTION OF ANGLE STATION.

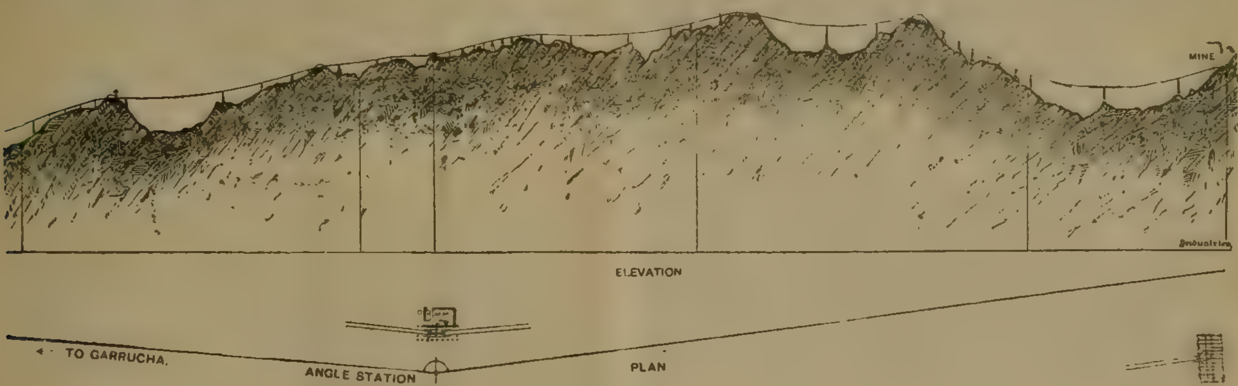



FIG. 17.

This line is divided into four sections, a 30 H. P. engine driving the two steeper sections, a 70 H. P. the other sections. In figs. 14 and 15 is also shown the method of taking up the slack of the hauling rope and keeping the same taut by means of balance weights. The carrying ropes are weighted at their ends in a similar manner.

At the loading station the trucks from the mine are run down a gravity incline to the ropeway station, and the contents tipped into bins or hoppers of a capacity of 800 tons. Fig. 18 gives a section of one of these bins, showing the buckets suspended from the shunt or hanging rail and the spouts for filling them. From the profile of the line, fig. 17, it will be seen that after leaving the loading station at Serena, which is situated some 905 ft. above the sea level, the line crosses a number of deep valleys, one upward of half a mile wide and 330 ft. deep, and traverses several mountain ridges, the highest being no less than 1,174 ft. above the sea level, to the village of Pinar de Bedar, where, at an elevation of 951 ft., the first engine house and angle station is situated. From here the line goes off at an angle to the right, and again passes over several valleys and ridges, with a gradual descent to a second angle station at an elevation of 370 ft. It then

bears to the left, passing over more or less hilly country to the second engine house, near Puerto del Coronel, situated at an elevation of 147 ft. From here it again turns to the right, descending at a comparatively easy gradient to the unloading station on the coast, near the town of Garrucha. We should here state that in fig. 17 the horizontal scale is double that of the vertical.

The line, which can be seen from end to end from the mountain ridge between Bedar and Serena, has a very imposing effect—the 660 buckets traveling backward and forward at a velocity of about three miles an hour, appearing smaller and smaller, until in the distance they look only like mere specks, the ropes in the sunlight like silver threads extending to the sea-shore. A spectator cannot help being struck with this system of transport when he sees how steadily and with what precision the carriers move over the deep valleys and steep ridges. The long spans vary from 328 ft. to 750 ft., the average distance of the supports from one another being about 130 ft. The unloading station at the coast is 150 ft. long and 32 ft. above the ground. This permits of 18,000 to 20,000 tons of ore being stored, so as to avoid delay in loading the vessels as they arrive. Electric signals are used, and the stations are connected by telephone.

The transport capacity specified for this line in the original contract was 600 tons per day of 10 hours, but of late, owing to the increased demand for this ore, the line has been working a double shift of 8 hours, and as much as 900 tons a day has been transported to the coast. Notwithstanding the many difficulties that had to be overcome, this line was surveyed and erected ready for use within ten months at a total cost of about $130,000.

There are now over 450 of the Otto ropeways at work in various parts of the world. Several have lately been started in the Transvaal, and are giving every satisfaction. The two most important lines out there are at the "Sheba" and the "Edwin Bray" mines, the former 2¾, the latter 3¾ miles in length, with gradients in places of 1 in 2 and 1 in 1.6, and spans of from 1,400 ft. to 1,600 ft.

A further application of these aerial lines is in the transport of goods, boxes, barrels, sacks, etc., between warehouses over buildings, railroads, canals, etc., where an ordinary line could not be employed. The loading and unloading is very rapid and easy, and can go on in all states of the weather. No purchase of land is necessary for the permanent way, but only the lease of a strip about 10 ft. wide is required, and this, with the exception of a small area at the points of support, can be cultivated in the usual way, the buckets traveling at such a height above the ground as not to interfere in any way with the men or cattle in the fields.

## TESTING RAILROAD MATERIALS.

THE accompanying table, which is taken from the report made to the Master Mechanics' Association by the Committee on Testing Laboratories, shows the work done in the Physical Laboratory of the Chicago, Milwaukee & St. Paul Railroad during the year 1890:

| Materials. | 1890. Amount Received. | 1890. Per cent. rejected. | Cost of Tests. |
|---|---|---|---|
| Axles | 5,927 axles | 5.3 | 68c. per 100. |
| Bar iron | 4,772 tons | 3.9 | 11.2c. per ton. |
| Boiler tubes | 6,991 tubes | 7.2 | 10.4c. per 100. |
| Chain | 50 tons | 3.7 | 10c. per ton. |
| Links and pins | 722 tons | 9.8 | 6c. per ton. |
| Springs—helical | 20,573 springs | 15.2 | 40c. per 100. |
| Springs—elliptic | 1,839 springs | 0.6 | $1 50 per 100. |
| Steel plate | 956 plates | 7.2 | 23.4 each. |
| Track bolts | 5,053 kegs | 3.8 | 92c. per 100 kegs. |
| Track spikes | 14,235 kegs | 15.5 | 16c. per 100 kegs. |
| Wire—barbed fence | 6,388 reels | [illegible] | 8c. per 100 reels. |
| Turnbuckles | 1,260 pieces | 00 | 10c. per 100. |
| Taps, dies and reamers | 384 pieces | 5 | $3 per 100. |

In general the tests show a decrease from former years in the percentage of material rejected, which would indicate increased care on the part of manufacturers.

## THE CANFIELD COMPOUND ENGINE.

THE accompanying drawing, fig. 1, shows a vertical compound marine engine, the distinguishing feature of which is a new valve. In this engine a single valve is used to operate the two cylinders, the exhaust from the high-pressure cylinder passing directly to the low-pressure cylinder through the valve itself. There is a single piston rod, to which both pistons are attached, and a single cross-head, the packing between the two cylinders being simple and easily accessible.

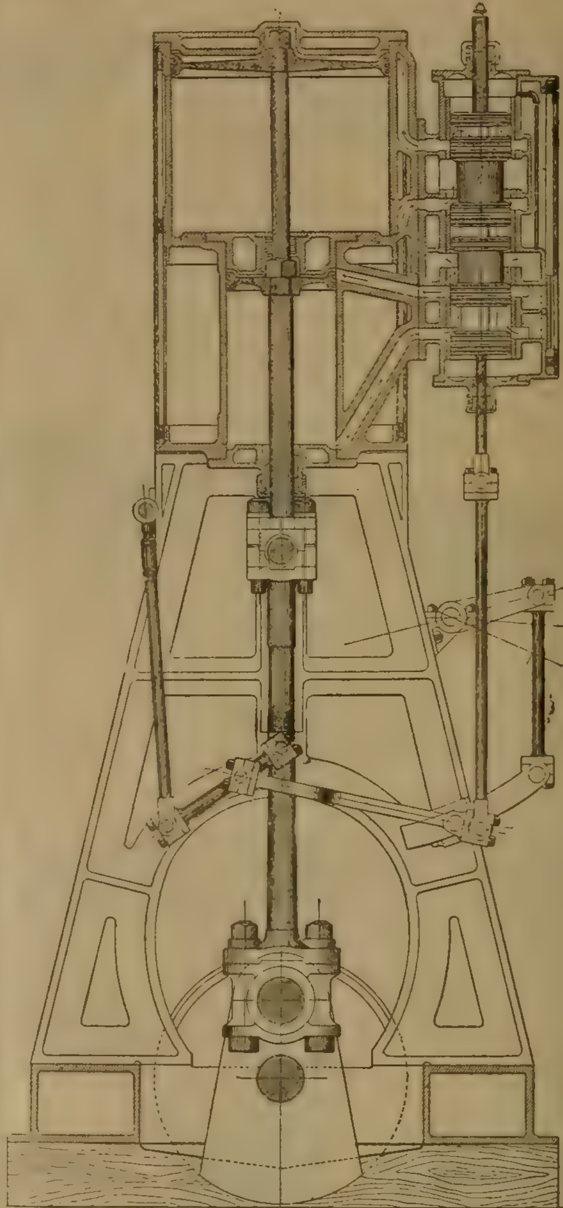


Fig. 1.

CANFIELD'S COMPOUND ENGINE.

The arrangement will be readily understood from the drawing, in which the pistons are shown just at the beginning of the stroke. The exhaust from the high-pressure cylinder passes, as indicated by the arrows, through the port into the steam-chest, then directly through the valve and by the upper port into the large cylinder.

In the engine illustrated the Joy valve gear is used, but

the valve may be operated by any of the usual motions. The advantages obtained in practice have been the relatively high pressure secured in the large cylinder, and the fact that condensation is reduced, the valve being surrounded by steam at high pressure, so that heat absorbed by the valve is passed directly to the steam on its passage to the low-pressure cylinder. In an engine of this kind in use on a tug-boat owned by the Pennsylvania Railroad a considerable gain in power was secured by the use of this valve. Indicator cards taken with an initial pressure of 100 lbs. in the first cylinder, cutting off at five-eighths of the stroke, show an initial pressure of 28 lbs. in the low-pressure, the ratio of the cylinders being 1 : 4. In the engine shown, which is the one referred to, the high-pressure cylinder is 18 in. and the low-pressure 36 in. in diameter.

The valve is fully balanced, the sizes of the valve-stem and tail-rod being so proportioned as to counterbalance the weight of the valve itself by the difference in pressure on the upper and lower ends.

The arrangement is certainly a very simple one, and seems excellently adapted to the compound engine. In the cases where it has been applied it has worked so well that it has been adopted for the engines of the new double-screw ferry-boat *Cincinnati* — which was described and illustrated in the JOURNAL for June last, page 273—and it will be used in other new boats for the same company.

Fig. 2 shows a design for the application of this valve to a four-cylinder compound locomotive. Here the cylinders are in tandem, the chief difference from the marine engine being that the cylinders are vertical instead of horizontal.

This valve is well suited to a quick-working engine, and it is to be applied to a vertical stationary engine. The arrangement will be substantially the same as in the marine engine shown in fig. 1. As in that case, it will be free from the objections made to the compound engine of the loss of heat in long connecting pipes and passages, which must be filled at each stroke.

This valve is the invention of Mr. Hobart Canfield, Master Mechanic in charge of the Pennsylvania Railroad repair shops at Hoboken, N. J., where the work on the ferry-boats and other floating equipment of the road is done.

## BIDS FOR NEW GUNS.

IN Washington, July 13, in the office of the Chief of Ordnance of the Army bids were opened for 100 new guns. These include 25 of 8-in. caliber, 50 of 10-in., and 25 of 12-in.; all to be breech-loading, rifled, built-up steel guns. Efforts made last year to secure favorable bids failed, and it was necessary for Congress to increase the appropriation for the procurement of these 100 guns to $4,225,000.

The proposals received were as follows:

*Midvale Steel Company.*—One 8-in. type gun, with ammunition for testing, $22,028, to be delivered in three years; 25 service guns of the same pattern at the same price each, to be delivered in eight years after acceptance of the type gun; one 10-in. type gun, $51,880, and 49 service guns at same price each, to be delivered in eight years; one 12-in. type gun, with ammunition, $88,592, and 24 service guns at the same price each, to be delivered in eight years.

*South Boston Iron Works.*—One 8-in. gun, $27,300; 350 rounds of ammunition, $24,332; 24 service guns, $20,695 each, deliveries to begin in 1894 and to be made at the rate of six per year; one 10-in. type gun, $60,560;

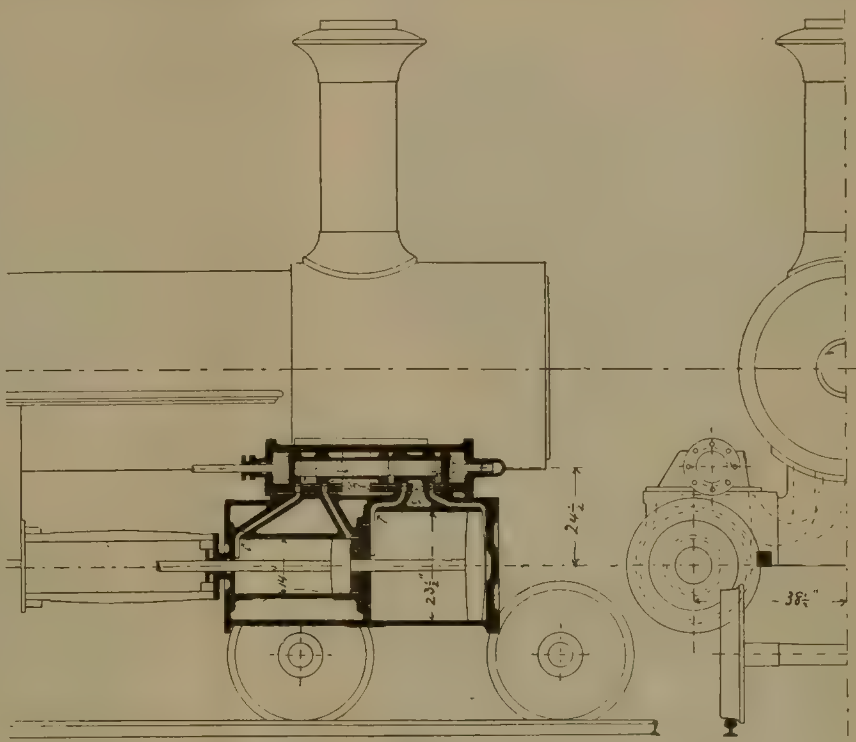



Fig. 2.
CANFIELD'S COMPOUND ENGINE.

ammunition for the same, $43,350; 49 service guns, $47,700 each, to be delivered five each year after 1895; one 12-in. type gun, $100,000; ammunition for same, $60,000; 25 service guns, with 10 rounds of ammunition, $79,500 each, to be delivered five each year after 1896.

*Bethlehem Steel Company.*—One 8-in. type gun, $43,893, delivered in 1,460 days, and $42,035 if delivered in 2,190 days; 24 service guns of same kind at $19,723 each, delivered in 552 days, or $17,246 if delivered in 730 days; one 10-in. type gun, $78,937, delivered in 699 days, or $73,755, delivered in 882 days; 49 service guns of this size at $40,929 each, delivered in 2,130 days, or $37,754, delivered in 3,404 days; one 12-in. type gun, $113,951, delivered in 791 days, or $106,558, delivered in 1,095 days; 24 service guns of this size at $61,846 each, delivered in 2,038 days, or $54,473, delivered in 3,194 days.

The Bethlehem bid was accompanied by some conditions, one looking to a change in the proportions of the hoops of the guns and another to allowances for advanced deliveries. The act of Congress gives authority to divide the awards, but at their longest periods of time the Bethlehem bids are still the lowest in each class, and their lowest total of $3,785,850 for the 100 guns is the only one within the limit of the appropriation. The total of the Midvale bid is $5,359,500, and of the South Boston bid $5,174,312.

## ENGLISH TIRE AND AXLE SPECIFICATIONS.

SOME time since the English Board of Trade called the attention of the General Managers' Committee of the Railway Clearing House to the fact that many cars owned by private parties—coal operators and the like—were not properly built or kept up to the standard required for railroad companies. In accordance with this, a system has been established by which all private cars are required to conform to certain standard specifications, and must pass inspection by some railroad company. Unless this has

been done, and a plate stating the fact attached to a car, it is not allowed to run on any railroad belonging to the Clearing House. The register-plates are of uniform design, a sample being shown in fig. 6.

From the specifications as prepared and approved by

Fig. 6


the General Managers' Committee, and published by the London *Railway Engineer*, we take the following sections as showing the standards adopted for wheels and axles :

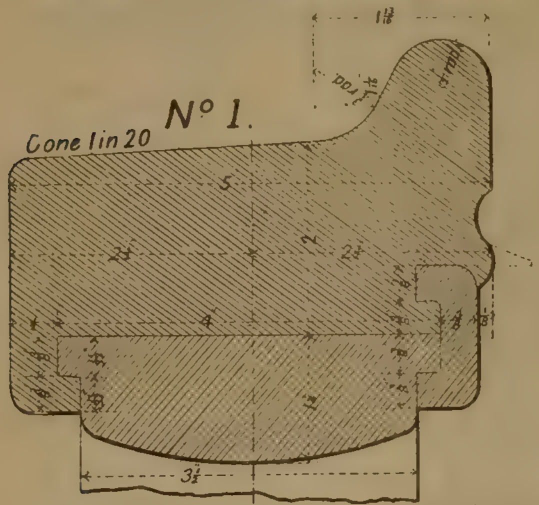
STANDARD WHEELS AND AXLES.

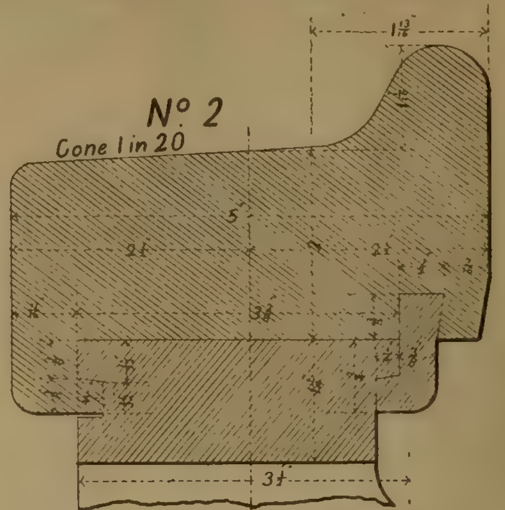
*Tires.*—13. The tires to be of Bessemer or Siemens' steel, and to be subjected to the tests set forth in clause 21.

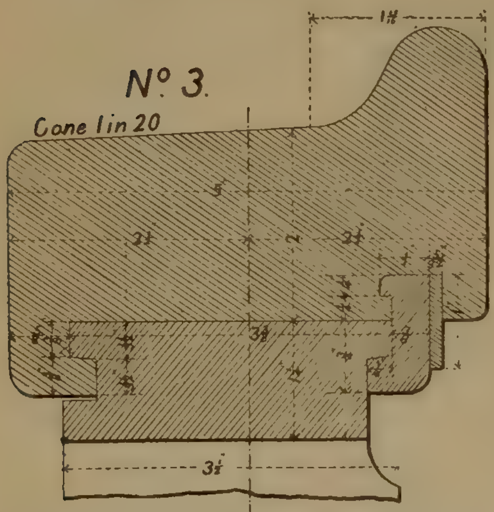
The tires to be 5 in. wide, and not less than 2 in. thick in the middle when finished, truly bored out, with not more than $\frac{1}{16}$ in. for contraction, and secured to the wheels by one of the several approved modes of fastenings shown in the standard drawings (figs. 1, 2, 3, 4 and 5) ; but neither rivets nor bolts to be passed through or into the tire.

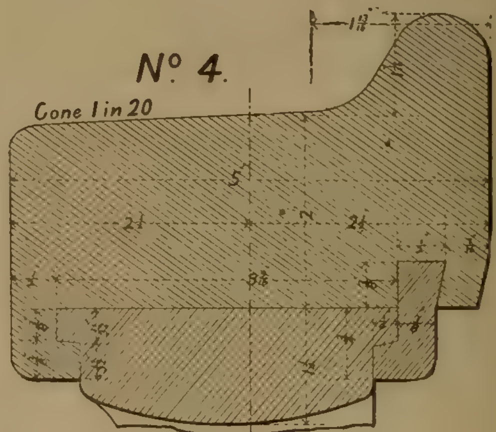
*Axles.*—14. The axles to be made of Bessemer or Siemens' steel, and to be subjected to the tests set forth in clause 21. Wrought-iron axles may be used if preferred, subject to the tests set forth in clause 22.

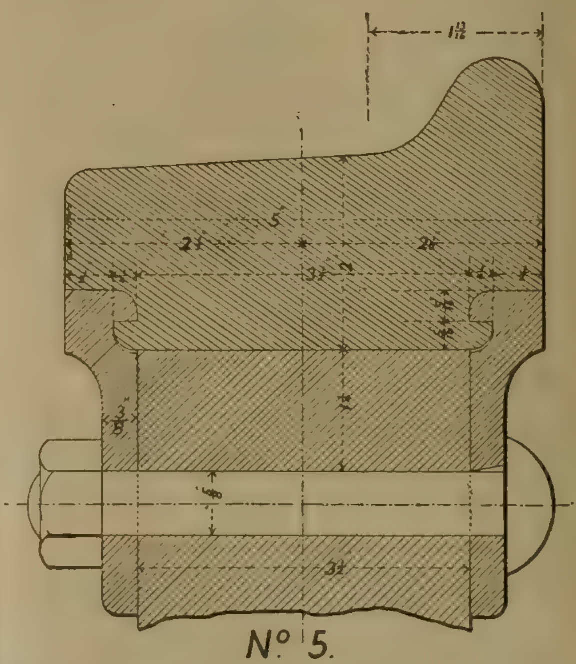
The axles to be 6 ft. 6 in. in length from center to center of journals, 5¼ in. diameter through the boss of the wheel, and gradually tapered to 4½ in. in the middle. There must be no shoulder on the axle behind the boss. The journals to be 8 in. long by 3¾ in. diameter, and the whole strictly in accordance with the standard drawing.




*Wheels.*—15. The body of the wheel to be made of wrought iron of good marked bar quality, with either solid or open spokes, and either wrought or cast-iron bosses.

The bosses to be 7 in. through; those made of wrought iron to be 9½ in. diameter; those of cast iron, 13 in. The rim or periphery to be not less than 1¼ in. thick, soundly welded throughout, and turned exactly to 2 ft. 9 in. diameter, and in section equal in strength to the form shown on the standard drawing. The boss to be bored out, and the wheel forced on to the axle by hydraulic pressure of not less than 30 tons, and no keys are to be used. If preferred, the body of the wheel may be cast of steel of equal dimensions.

*Stamping of Ironwork and Steelwork.*—16. All Ironwork and Steelwork to be stamped distinctly with the Name or Initials of the Owner, and the day, month, and year when made.

TESTS OF WHEELS AND AXLES.

*Testing of Steel Tires and Axles.*—21. *A.* Each tire of the diameter of 3 ft. 1 in. to be guaranteed to stand, without fracture, the test of being compressed 4 in. by hydraulic power, the compression to be continued until the tire is broken. Also, each tire must be guaranteed to stand a tensile strain of not less than 35 tons per square in., with 25 per cent. of elongation; the test length to be 3 in.

*B.* The axles to be capable of standing the following test, without fracture, viz., five blows from a weight of 2,000 lbs. falling from a height of 20 ft. upon the axle, which shall be placed upon bearings 3 ft. 6 in. apart, and turned after each blow. After the fifth blow the axle to be broken. Also, each axle to be guaranteed to stand a tensile strain of not less than 35 tons per square in., with 25 per cent. of elongation; the test length to be 3 in.

*C.* The maker shall provide, at his own expense, one additional tire and one additional axle in every 50, or any less number ordered, to be selected from the bulk by the inspector, for testing in the manner above described, after which they shall be given up to the buyer, if required.

*D.* The tires and axles tested to be held to represent correctly the quality of the lots from which they are taken.

*E.* Each tire and axle to be stamped, while hot, with the day, month, and year when made; and any tire or axle failing before it has run 12 months, to be replaced at the expense of the maker.

*F.* The maker's name to be well stamped upon each axle, and on the outer edge of each tire.

*Testing of Wrought-Iron Axles.*—22. *A.* The axles to be capable of standing the following test, without fracture, viz., five blows from a weight of 2,000 lbs. falling from a height of 20 ft. upon the axle, which shall be placed upon bearings 3 ft. 6 in. apart, and turned after each blow. After the fifth blow the axle to be broken.

*B.* Also each axle to be guaranteed to stand a tensile strain of not less than 22 tons per square in., with not less than 25 per cent. of elongation; the test length to be 3 in.

## Rapid Transit in New York.

The engineers of the Rapid Transit Commission have been making a series of borings to ascertain exactly the nature of the ground through which the underground line proposed by the commission is to be built. It is stated that the results are very satisfactory. The formation through which the proposed tunnel road is to be constructed is peculiarly susceptible to tunneling. The soil is sandy all along the line, fine red in quality from the Battery to Chambers Street, with now and then a stratum of coarse grit. North of Chambers Street the sand is coarse and gritty, impregnated with gravel very thickly at Canal and Broome streets, and with occasional drifts of fine red sand.

The construction of the road will undoubtedly be by means of a shield, and there is found no obstruction to its use along the entire line through the business section of the city, from the Battery to Eleventh Street. The excavation can be done and the tunnel constructed without any blasting operations whatever and without doing anything that will interfere with the foundations of buildings, except at Twenty-seventh Street, where private property will have to be acquired. The results have been so surprising with respect to Canal Street and Duane Street that the engineers have ordered proof borings to be made at these points, without, however, having any reason to expect a different result. The record, which will be esteemed of value as a reference by property owners in Broadway, is given herewith in its entirety. It is the record of the first scientific exploration of subterranean Broadway that has been made:

| | Feet to Bed Rock. | | Feet to Bed Rock. |
|---|---|---|---|
| *Whitehall Street.* | | Walker | 107.20 |
| Front Street | 20.00 | Lispenard | 68.25 |
| Water | 23.00 | Canal | 87.65 |
| Pearl | 16.00 | Howard | 50.00 |
| Bridge | 20.00 | Grand | 70.80 |
| Stone | 21.00 | Broome | 47.75 |
| Beaver | 34.00 | Spring | 70.10 |
| *Broadway.* | | Prince | 70.00 |
| Morris | 35.25 | Houston | 105.60 |
| Exchange Alley | 51.50 | Bleecker | 66.15 |
| Rector | 63.10 | Bond | 68.85 |
| Wall | 60.10 | Third | 53.00 |
| Pine | 70.00 | Fourth | 40.10 |
| Cedar | 70.75 | Washington Place | 34.55 |
| Liberty | 70.90 | Waverly Place | 48.85 |
| Cortlandt | 70.30 | Astor Place | 49.75 |
| Dey | 76.85 | Clinton Place | 65.25 |
| Fulton | 83.25 | Ninth | 35.25 |
| Vesey | 81.50 | Tenth | 40.33 |
| Barclay | 101.15 | Eleventh | 31.15 |
| Park Place | 112.50 | Twelfth | 22.00 |
| Murray | 113.50 | Thirteenth | 34.00 |
| Warren | 109.20 | Fourteenth | 13.35 |
| Chambers | 100.75 | Seventeenth | 10.15 |
| Reade | 116.00 | Twenty-first | 17.00 |
| Duane | 163.50 | Twenty-third | 21.50 |
| Thomas | 138.50 | Twenty-fifth | 24.00 |
| Worth | 147.50 | Twenty-seventh | 19.20 |
| Leonard | 96.55 | Thirtieth | 15.00 |
| Franklin | 83.45 | Thirty-third | 4.00 |
| White | 105.50 | | |

Deep depressions in the bed rock are noted at Duane Street, at White and Walker streets, and at Houston Street. But the satisfactory feature of the showing is that rock excavation will be required only through Whitehall Street and from Eleventh Street northward. All the sub-surface works lie within 8 ft. of the street grade. The tunnel construction need not begin any deeper than 10 ft. below the surface, and will occupy a space below that of only about 20 ft. For the purpose of the tunnel, therefore, 30 ft. of soil above bed-rock will be sufficient. At no place between Beaver and Eleventh streets is there a less depth than 34 ft.—*New York Times.*

## THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.



(*Continued from page* 324.)

### CHAPTER XII.

PROJECTIONS.*

In representing different views of an object it is often convenient or essential to extend or "project" lines from one view to define the position of the parts in another view. Some simple methods of doing this were explained in Chapters IV. and V. In this chapter some of the more difficult principles and methods of representing different views of mechanical objects will be explained.†

PROJECTIONS OF A CUBE.

Fig. 280 is a perspective view of a cube, the sides of which are all 1 in. × 1 in. The top is numbered 1, its sides 2, 3, 4, and 5, and the bottom 6, so that the different views may be easily identified.‡ The edges and figures, which are hidden from view, are represented by dotted lines.

* In treating this branch of mechanical drawing, very free use has been made of "The Engineers' and Machinists' Drawing Book," published by Blackie & Son, of London and Edinburgh, but which is now out of print. Some of this chapter and some of the engravings in it have been taken from that book.

† The student should draw the exercises given in this chapter twice the size of the engravings.

‡ This is not a true perspective view, but for the present purpose it will answer our purpose better than a correct view would, as the length of all the sides is of the correct dimension, or 1 in.

PROBLEM 103. *To draw projections of a cube.*

To represent a geometric view of the front side, 2, we should draw a square, as represented by *a b c d* in fig. 281. To represent a view of the right-hand side, 3, we can extend or "pro-

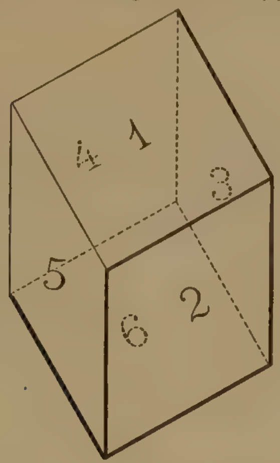



Fig. 280.

ject" the line *a b*, which forms the upper side of the front view, toward the right, and the projection *e f* of this line will then represent the upper edge of the right-hand side view. In the same way the lower edge *d c* may be projected toward the right, and both *a b* and *d c* may both be projected toward the left to delineate the side view of the left-hand side, 5; *e g*, *f h*, *i k* and *j l* can then be laid down, and the views of the right and left-hand sides of the cube are then completed. In a similar way the sides *a d* and *b c* may be projected above and below the front view to represent the plan 1 and inverted plan 6.* This is all very simple, and although it facilitates the drawing of the different views yet their dimensions could readily be laid down without projecting the lines of one view to represent another.

PROBLEM 104. *To draw projections of a cube which is standing on one of its edges.*

Let it be supposed that the cube is standing on one edge, as shown in the front view, 2, fig. 282. To represent either side view it is essential, in order to fix the positions of the edges *e f*, *w x*, *k l* and *i j*, to project lines from *a* to *w x* and *i j*, from *b* to *e f*, and from *d* to *k l*. This is also true of the plan and inverted plans, and in drawing these the positions of the vertical lines *y z*, *p o*, *n m*, *q v*, *s t* and *u v* can only be determined by projecting lines from *a b c* and *d*.

The drawing of a hexagonal bolt head or nut, explained in Chapter V., is another illustration of the application of the principle of projecting one view from another.

PROJECTIONS OF A PYRAMID.

PROBLEM 105. *To draw a projection of a pyramid.*

On inspecting figs. 283 and 284, it will be seen that two distinct geometrical views are needed to convey a complete idea of the form of the object—namely, a side view or elevation, fig. 283, to represent the sides of the body, and to express its height; and a plan of the upper surface, to show the form as seen in looking down on it from above.

It should be observed that this body has an imaginary axis or center-line, *S G*, about which the same parts are equally distant. A figure of this kind, or one which may be supposed to consist of two halves of the same form joined together, is said to be *symmetrical*. A prism, fig. 289, or a cone, fig. 295, for instance, may be cut in two halves through its axis or center line, and each part will be of the same form. This is also true of a pyramid.

To represent a pyramid, in the first place, a horizontal straight line *L R*, fig. 283, should be drawn. This line will represent what may be called the *ground-line* or base on which the pyramid rests. Then draw a perpendicular *S G* to this base and extend it below *L R*.

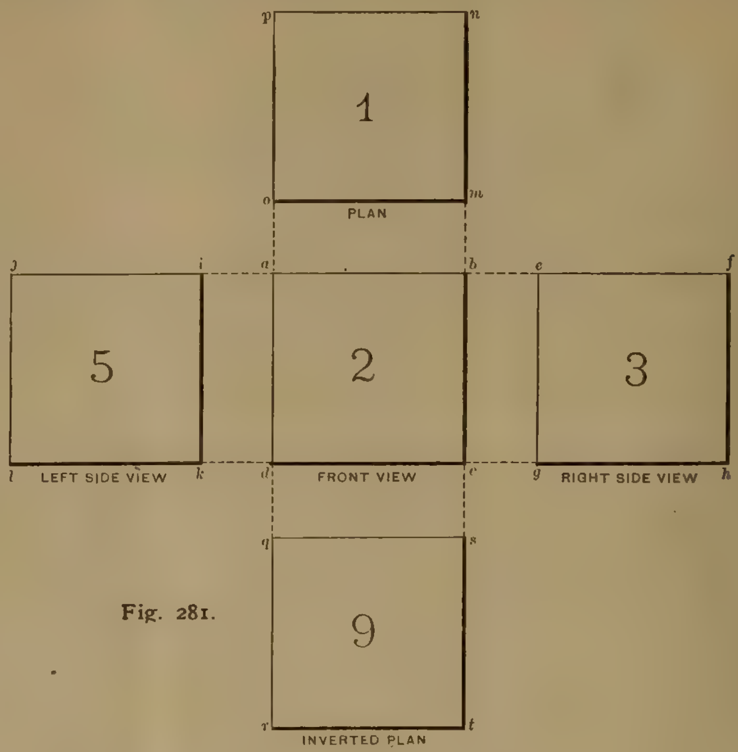



Fig. 281.

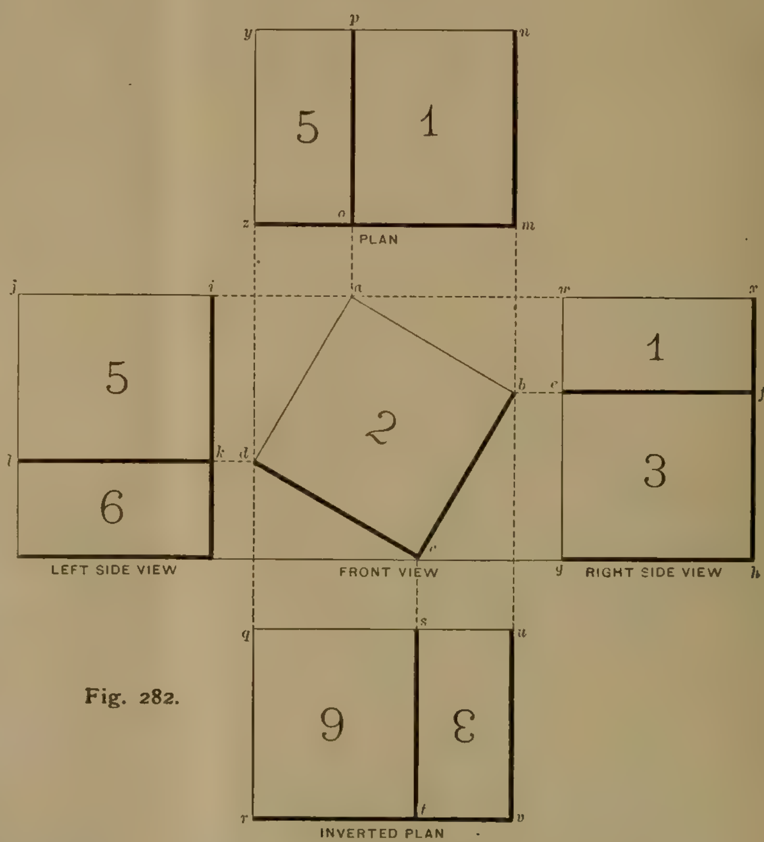



Fig. 282.

The plan or top view of the pyramid should then be drawn. To do this take any convenient point as *S'* below *L T*, and, if the pyramid is hexagonal, draw a hexagon *A' B' C' D' E' F* about the point *S'*. The methods of doing this were described in Chapter III. The most convenient way is to draw a circle

* It will be observed that the 6 in fig. 280 is shown upside down in fig. 281.

from the center $S'$, whose diameter $a\ b$ is equal to that of the base of the pyramid measured over its sides. Then with a T-square and a 30° and 60° triangle draw the sides of the hexagon tangent to the circle. This hexagon will represent the base of the pyramid.

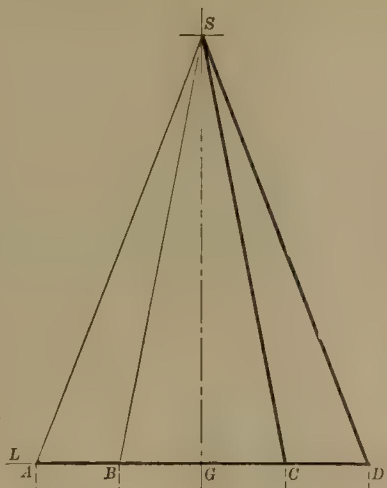
Then from $G$ lay off a distance $G\ S$ equal to the height of the pyramid. In order to show the position of the corners of the base in the side view, fig. 283, draw perpendicular lines $A'\ A$, $B'\ B$, $C'\ C$, and $D'\ D$ from the corners $A'\ B'\ C'$ and $D'$, intersecting the horizontal line $L\ R$ at $A$, $B$, $C$ and $D$. These points will represent the position of the corners or angles of the base of the pyramid in fig. 283. As the sides of all unite in a common point $S$, called the *vertex*, by drawing lines $A\ S$, $B\ S$, $C\ S$ and $D\ S$ joining the angles $A$, $B$, $C$ and $D$ with $S$, they will represent the intersections of the sides, and will complete the side view of the figure.

To complete the plan, draw lines from the angles $A'\ B'\ C'$—$F'$ to the center $S'$.

Problem 106. *To draw the same pyramid, having its base A D, fig. 285, in an inclined position to the ground-line, but with its edge, B C, fig. 285, parallel to the vertical plane or the surface of the paper.*

It is evident that, with the exception of the inclination, the side view of the pyramid will be the same as in the preceding example,

Fig. 283.



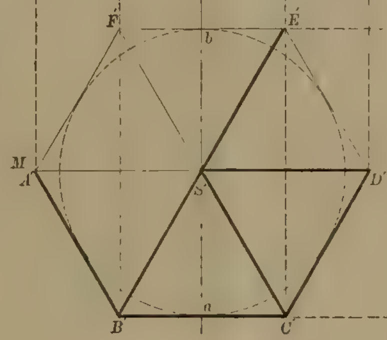
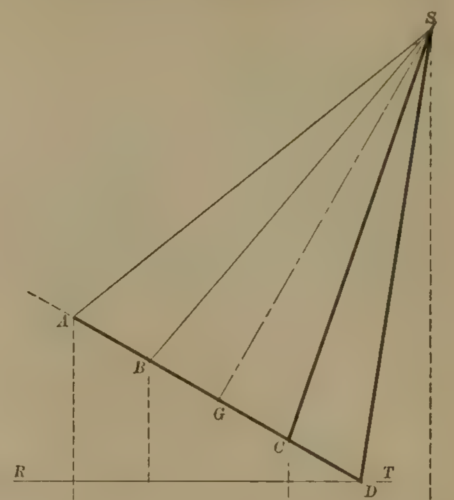




Fig. 284.

Fig. 285.



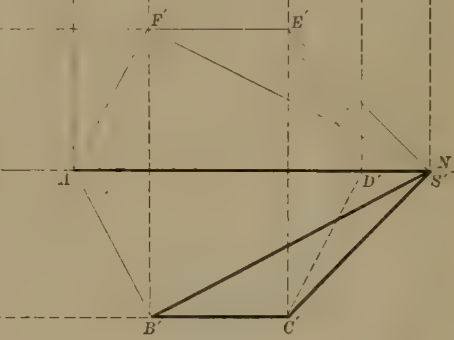




Fig. 286.

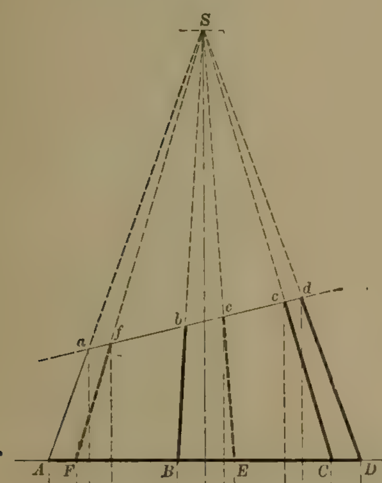



Fig. 287.

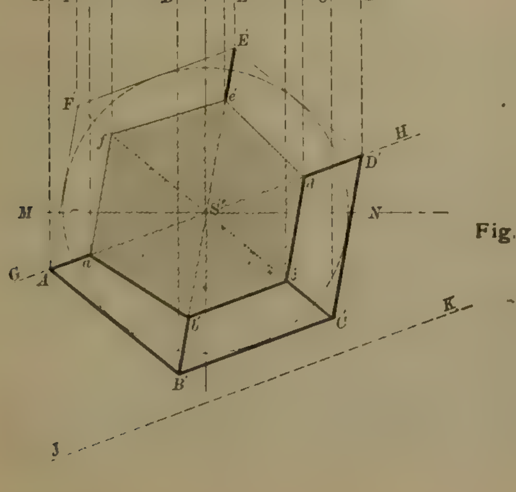



Fig. 288.

and it is therefore only necessary to copy fig. 283. For this purpose, after having fixed the position of the point $D$ upon the ground-line $R\ T$, draw through this point an indefinite straight line $D\ A$, making with $R\ T$ an angle equal to the desired inclination of the base of the pyramid. Then with a pair of dividers take from fig. 283 the distance $G\ A$ or $G\ D$, equal to half of the base, and lay it off from $D$, in fig. 285, to $G$, and from $G$ lay off the same distance $G\ A$; then $D\ A$ will represent the base of the inclined pyramid. As the axis must still, as in the former case, pass perpendicularly through the center of the base, the line $G\ S$ should be drawn through $G$ and perpendicular to $A\ D$. From $G$ lay off the height $G\ S$ equal to the height of the pyramid. Then take the distance $C\ D$ or $A\ B$, from fig. 283, and lay it off from $D$ and $A$, in fig. 285, to $C$ and $B$, which will be the positions of the angles of the base. Unite these angles with the vertex $S$ by lines $A\ S$, $B\ S$—$D\ S$ and the side elevation of the pyramid will be completed.

If the plan, fig. 286, of the inclined pyramid is drawn on the same center line $A'\ S'$ on which fig. 284 is represented, draw from $D$, fig. 285, a perpendicular line $D\ D'$; then $D'$ will represent the position in the plan of the corner or angle $D$ on which the pyramid rests. In the same way draw a perpendicular from $A$ intersecting $A'\ S'$ at $A'$, and this will represent the position of the angle $A$ in the plan. As the sides $F'\ E'$ and $B'\ C'$ are supposed to be parallel with the horizontal center line $M\ N$, those sides may be most conveniently drawn by projecting the lines $F'\ E'$ and $B'\ C'$, of fig. 284, to fig. 286. Then from the angles $B$ and $C$, of fig. 285, draw perpendiculars $B\ F'\ B'$ and $C\ E'\ C'$ intersecting $F'\ E'$ and $B'\ C'$; then $F'\ E'$ and $B'\ C'$ will represent the positions of the angles of the base in the plan, and the sides $A'\ B'$, $C'\ D'$, $D'\ E'$ and $F'\ A'$ may be drawn to complete the base. The position of the vertex $S$, in fig. 286, may be determined by drawing a perpendicular from $S$ intersecting $M\ N$ at $S'$. Then by uniting the angles $A'\ B'\ C'$—$F'$, in fig. 286, with lines drawn to $S'$ the plan will be completed.

Problem 107. *To draw a side view of a pyramid none of whose sides are parallel or perpendicular to a straight or perpendicular line.*

Having drawn, as before, the vertical $S\ S'$, figs. 287 and 288, which is the center line of the figures, its point of intersection $S'$ with $M\ N$ will be the center of the plan. From this point, then, as a center, draw, as in fig. 284, a circle of the required diameter, and circumscribe a regular hexagon about it. Since none of the sides of the base are to be parallel with a horizontal or perpendicular line, draw a diameter $G\ H$, making the required angle with $M\ N$, and draw lines $F'\ E'$ and $B'\ C'$ parallel to $G\ H$ and tangent to the circle. Then draw a line $J\ K$ parallel to $G\ H$ and at any convenient distance from it, but outside of the figure. Lay a triangle or straight edge so as to coincide with $J\ K$, and with a 60° triangle draw the sides $A'\ B'$, $C'\ D'$, $A'\ F'$, and $E'\ D'$ tangent to the circle. These lines will form the hexagon, which is the base of the pyramid. From the angles $A'\ B'\ C'$—$F'$ erect perpendiculars cutting the ground-line $A\ D$ at $A$, $F$, $B$, $E$, $C$ and $D$. These points of intersection will represent the positions of the corners of the pyramid in the side elevation. From the ground-line lay off the height of the pyramid to $S$, and draw lines $A\ S$, $B\ S$, $C\ S$, and $D\ S$ and the side view will be completed.

PROBLEM 108. *To draw the plan of a transverse section of a pyramid, made by a plane cutting it at an angle to its perpendicular.*

If the cutting plane is represented by the line $a\ d$, fig. 287, in the elevation, it is obvious that it will expose, as the section of the pyramid, a polygon whose angular points will be at the intersections of the various edges or corners of the pyramid with the cutting plane—that is, the point where the plane $a\ d$ intersects the side $S\ D$ must be on the line $a\ d$, in fig. 287, and on the line $S'\ D'$, in fig. 288. Consequently by drawing a perpendicular $d\ d'$ from $d$ intersecting $S'\ D'$ at $d'$, then $d'$ will represent in the plan the point of intersection of the plane with the corner $S'\ D'$. By drawing other perpendicular lines from $c$, $e$, $b$, $f$ and $a$ intersecting $S'\ C'$, $S'\ B'$, etc., at $c'$, $b'$, etc. the position of all the angles of the intersecting polygon $a'\ b'\ c'\ d'\ e'\ f'$ will be determined. By uniting these angles by straight lines $a'\ b'$, $b'\ c'$, etc., they will form the outline of the polygon which represents the plan of the intersection of the cutting plane with the pyramid.

PROJECTION OF A PRISM.

PROBLEM 109. *To represent a regular six-sided prism, which is in an upright position, in a side view and plan.*

Ground lines and center lines should be drawn, in figs. 289 and 290, as in the previous examples. Then from $S'$ draw a circle whose diameter is equal to the short diameter of the hexagonal base, and circumscribe a hexagon $A'\ B'\ C'\ D'\ E'\ F'$ about it. Project the base thus delineated by perpendiculars to the ground-line $G\ K$, fig. 289, from each of its angular points; and since the prism is upright, it is obvious that these angular points themselves represent the horizontal projections of all its edges, and that their elevations coincide with the perpendiculars $A'\ G$, $B'\ H$, etc. Set off from $G$ to $A$ the height of the prism, and through $A$ draw $A\ D$, parallel to the ground-line. This will be the vertical projection of the upper surface. The edges being all parallel to the vertical plane, are, of course, seen in their actual length.

Fig. 289.

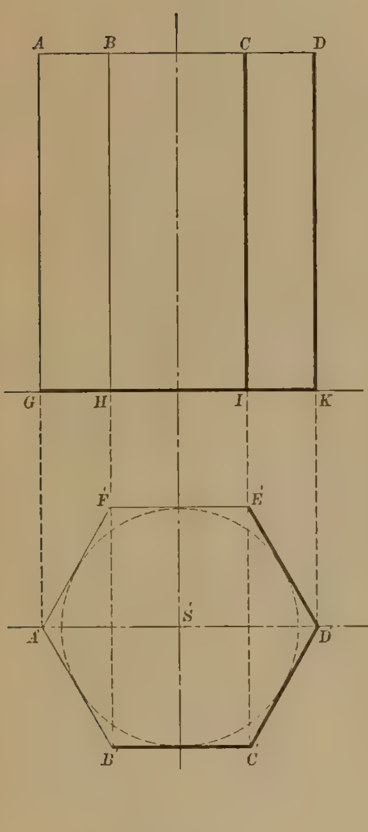


Fig. 290.

Fig. 291.

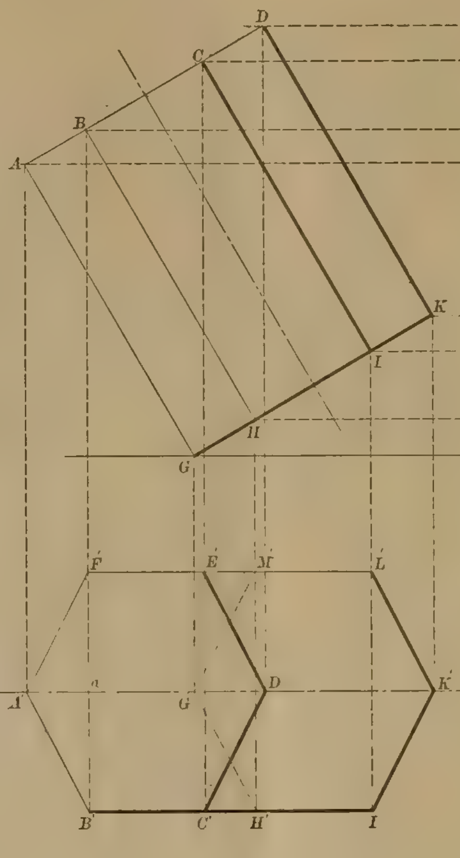


Fig. 292.

Fig. 293.

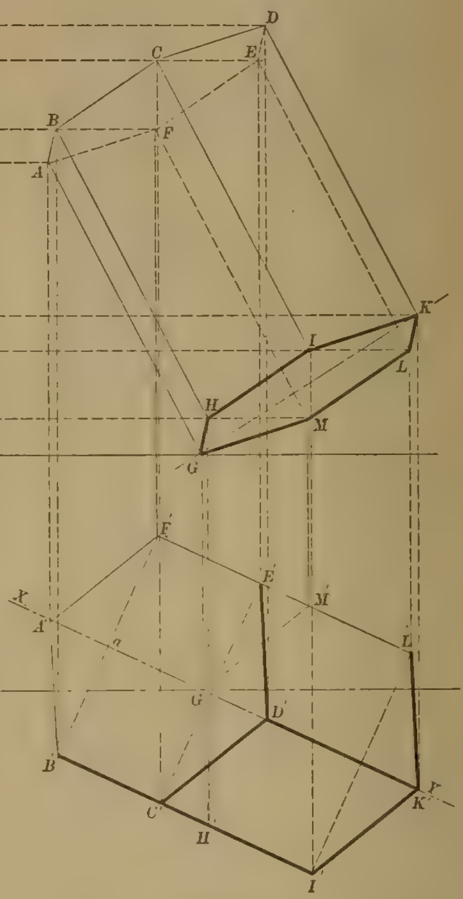


Fig. 294.

PROBLEM 110. *To draw the same prism, supposing it to have been turned on the point G, fig. 291, and to stand in an inclined position, as shown.*

The method of proceeding in this case is so similar to that explained in drawing an inclined pyramid that little explanation is needed excepting that which the engravings themselves afford. The view of the prism in fig. 291 is exactly like that shown by fig. 289, the position alone being different. All that is needed, then, is to draw it on the inclined base $G\ K$, and the plan may then be constructed by projecting perpendicular lines downward, as explained in the preceding examples.

PROBLEM 111. *To draw the same prism in two views when it is inclined in two directions or to both planes of projection.*

Assuming that the inclination of the prism upon the horizontal plane is the same as in the preceding figures, which, for the sake of simplifying the operation, we shall suppose to be already constructed, and that the line $G\ K$, fig. 293, repre-

sents the inclination of the base to a horizontal plane, and that the line $X$ $Y$, in fig. 294, represents its inclination to a vertical plane. The first process, then, is to copy fig. 292, and draw it on the center line $X$ $Y$. To do this, first set off upon this line a distance $A'$ $G'$ equal to $A'$ $G'$ of fig. 292; transfer the distances $G'$ $K'$ and $D'$ $K'$ from fig. 292 to fig. 294; and, in order to find the remaining angular points, make $A'$ $a$ equal to the corresponding distance in fig. 292, and through $a$ draw $B'$ $F'$ perpendicular to the center line, and transfer the distances $a$ $B'$, $a$ $F'$. Through the points $B'$ and $F'$ draw straight lines parallel to $A'$ $K'$, and join $A'$ $B'$, $A'$ $F'$; and since we have already seen that all the other sides of the polygon must be parallel to one of these two, the figure may be completed by drawing through the points $G'$ $D'$ and $K'$ straight lines parallel to $A'$ $B'$ and $A'$ $F'$ respectively.

Now, since the prism has been supposed to have preserved its former inclination to the horizontal plane, it is obvious that every point in it, such as $A$, fig. 293, has, in assuming its new position, simply moved in a horizontal plane, and will, therefore, be in the line $A$ $A$ drawn from $A$, of fig. 291, and parallel to the ground-line, and since the same point has been projected to $A'$, fig. 294, it will also be in the perpendicular $A'$ $A$ drawn from $A'$, in fig. 294; the point of intersection $A$, fig. 293, is, therefore, the projection of $A'$ in the elevation or side view. The remaining angular points, in this view, are all determined in the same manner—that is, by projecting horizontal lines from fig. 291 and vertical ones from fig. 294; and then joining the contiguous points and the corresponding angles of the upper and lower surfaces, we obtain the complete vertical projection of the prism in its doubly inclined position.

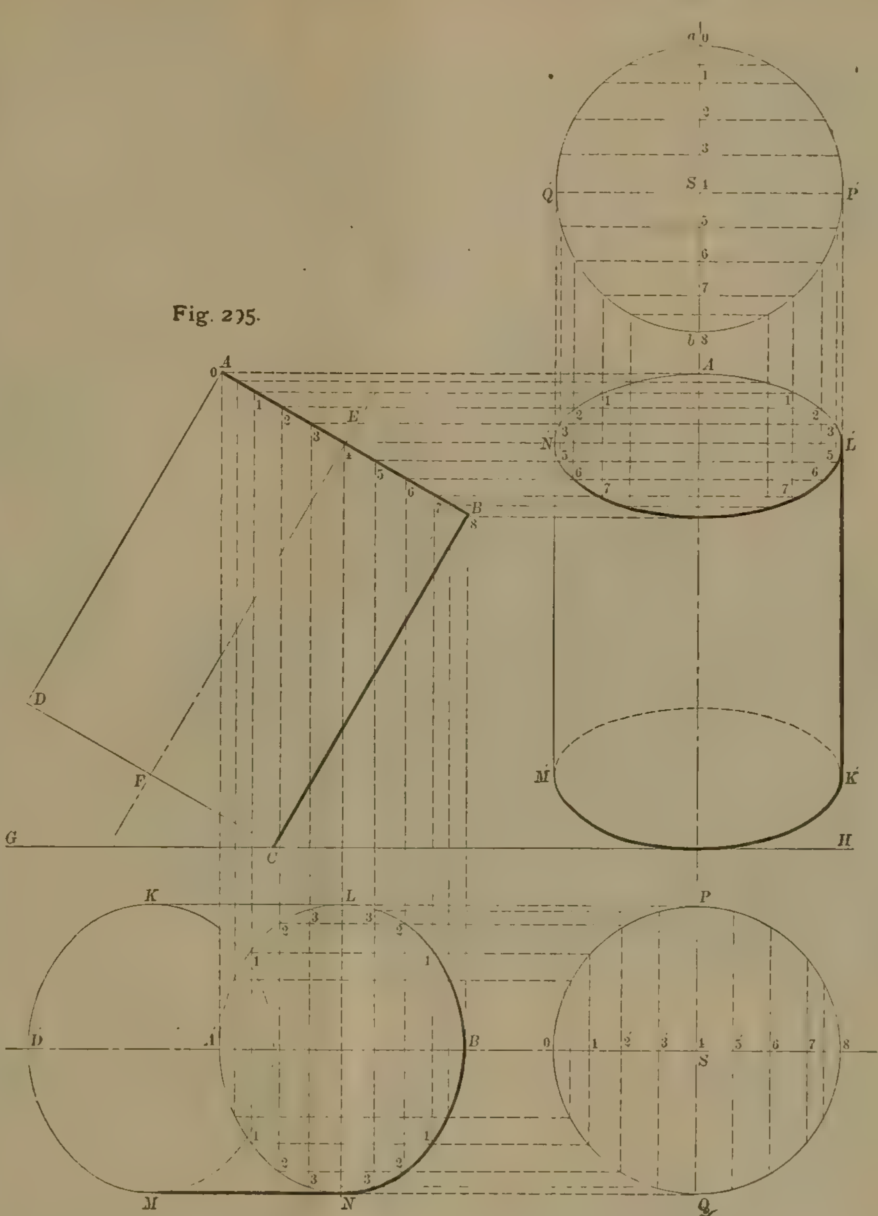


Fig. 297. Fig. 295. Fig. 298. Fig. 296. Fig. 299.

PROBLEM 112. *To draw a side view, plan and end view of a cylinder whose axis is inclined to a horizontal plane.*

Let $A$ $B$ $C$ $D$, fig. 295, represent a side view of a cylinder the axis $E$ $F$ of which is inclined to the horizontal plane $G$ $H$. To draw the plan, fig. 296, first draw a center line $D'$ $B'$ parallel to $G$ $H$, and at any convenient distance below it. Then from the corners $A$ $B$ $C$ and $D$ of the cylinder draw perpendiculars to $D'$ $J$. These will define the length of the cylinder in the plan. Next take a center $S'$ on $D'$ $B'$ extended, and with a radius $S'$ $P$ equal to $D$ $F$, half the diameter of the cylinder, describe a circle which will represent the end of the cylinder. From the top $P$ and bottom $Q$ of this figure project horizontal lines $P$ $L$ $K$ and $Q$ $N$ $M$; then $L$ $K$ and $N$ $M$ will define the sides of the cylinder in fig. 296. To represent the outline $L$ $A'$ $N$ $B'$ of the end of the cylinder subdivide the line $A$ $B$, which represents the top of the cylinder in fig. 295, into any number of equal parts 1, 2, 3, etc., in this case eight, and draw perpendiculars down from the points of division intersecting $D'$ $B'$. Next subdivide the diameter $O$ $J$ of the circle represented by fig. 299 into the same number of equal parts, as $A$ $B$, fig. 295, has been divided into, and draw perpendiculars to o 8' through these points and intersecting the circumference of the circle. From the points of intersection project horizontal lines cutting the perpendiculars which have been drawn through 1, 2, 3, etc., of fig. 295. The points 1, 2, 3, etc., when these two sets of lines intersect each other, in fig. 296, will be points in the curve which will represent the projection of the end of the cylinder in the plan, fig. 296. It should be explained that the projection of a circle which is inclined to the plane on which it is represented is always an ellipse. The curve $L$ $A'$ $N$ $B'$ drawn through the points 1, 2, 3, etc., can, therefore, be drawn in the manner explained in Chapter XI. The curve $K$ $D'$ $M$, representing the other end of the cylinder, may be drawn in the same way by subdividing the line $D$ $C$, which represents the lower end of the cylinder, and projecting lines down to $D'$ $B'$. As the ellipse, which represents the lower end of the cylinder in the plan, will be exactly like that which shows the upper end when the one has been delineated, the other may easily be repeated when its length and breadth are defined.

The explanation of this method of drawing the projection of the circle, which represents the end of the cylinder, is that the perpendicular lines drawn from the divisions 1, 2, 3, etc., of fig.

295, represent ordinates of the ellipse in fig. 296, which is the projection of the end of the cylinder and determines the position of the ordinates in fig. 296. The perpendicular lines in fig. 299 are ordinates of the circle which represents the end of the cylinder, and their intersection with the circumference gives their length. By projecting horizontal lines from their extremities to fig. 296 determines the length of the corresponding ordinates of the ellipse *L A′ N B′*.

To draw an end view of the cylinder *A B C D*, first lay down a perpendicular center line *A′ P* at a convenient distance on one side of fig. 295. On this line extended with a center *S* in any convenient position draw a circle whose diameter is equal to that of the cylinder, and from the two sides *P′* and *Q′* project perpendicular lines *P′ L′ K′* and *Q′ N′ M′* downward. These will represent the sides of the cylinder. Then from the points 1, 2, 3, etc., on *A B*, fig. 295, project horizontal lines crossing the center line *A′ P*. Next subdivide the diameter *a b*, fig. 297, into eight equal parts, and draw horizontal lines through the points of division 1, 2, 3, etc., and intersecting the circumference of the circle. From these points of intersection project perpendicular lines downward, to intersect the horizontal lines drawn from the points 1, 2, 3, etc., of fig. 295, to fig. 298. The points 1, 2, 3, etc., where the corresponding perpendicular and horizontal lines intersect each other in fig. 298, will be points in the curve which represents the end view of the top of the cylinder.

Fig. 305.

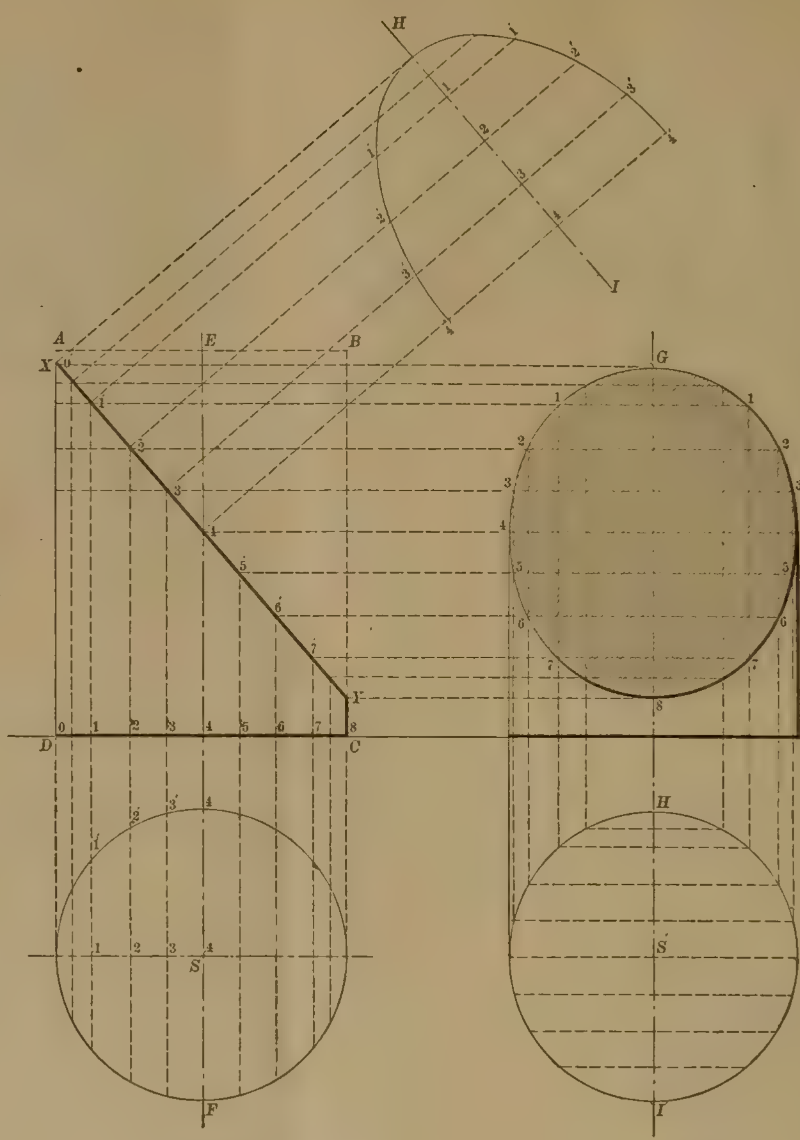



Fig. 300.

Fig. 303.

Fig. 301.

Fig. 304.

In making such projections it will often be well to subdivide some of the divisions, as 0 1 and 7 8, in figs. 295 and 297, through which projecting lines are drawn in order to get more points in some parts of the curve to be laid out. The circle shown in fig. 299 would answer for laying out both figs. 296 and 298 by subdividing the diameter *P Q*, of fig. 299, the same as *a b* of fig. 297, and drawing horizontal and vertical projection lines to fig. 298; but in the engravings separate circles for each view have been represented to avoid confusion.

PROBLEM 113. *Given the side view of a cylinder A B C D, fig. 300, and the direction of a plane, X Y, cutting it obliquely to a horizontal plane; required to find first the horizontal projection of this section; and, secondly, the outline of the section thus formed.*

First subdivide the base *D C* of the cylinder into any number of equal parts, 1, 2, 3, etc., eight in this instance, and draw perpendicular lines through these points and intersecting the plane *X Y*. On the right side of fig. 300 draw a vertical center line *G H I*, fig. 303, and on this center line below fig. 303 take a center *S′* and draw a circle, fig. 304, whose diameter is equal to that of the cylinder. Subdivide the vertical diameter *H I* of this circle into the same number of equal parts as the base *D C* has been divided into, and draw horizontal lines through the points of division cutting the circumference of the circle. From the points of intersection draw vertical lines upward and from the points 1′, 2′, 3′, etc., in the cutting plane *X Y*, fig. 300, draw horizontal lines intersecting in fig. 303 the vertical lines drawn from fig. 304. The points of intersection 1, 2, 3, etc., in fig. 303, will be points in the outline of the horizontal projection of the section *X Y*.

In this view it will be observed the section is foreshortened. To represent the correct form of the section, draw a center line *H I* at some distance from *X Y* of fig. 300, and parallel to it. From the points, 1′, 2′, 3′, etc., in the plane *X Y*, draw lines perpendicular to it and intersecting *H I*. On the center line *E F*, extended below fig. 300, take a center *S* and draw a circle, fig. 301, of a diameter equal to that of the cylinder. Extend the vertical lines which are drawn through the points 1, 1′, 2, 2′, 3, 3′, etc., so as to cut the circumference of the circle, fig. 301. From this figure take with dividers half the length 1 1′ of the vertical line included within the circle and set it off from the center line *H I*, in fig. 305, on the line drawn through 1′, in fig. 300. Similarly take the distance 2 2′ from fig. 301, and set it off in fig. 305 on the line drawn through 2′ of fig. 300. In the same way points may be laid off on the other lines in fig. 305, and these will be points in the outline of the section *X Y*, which can then be drawn through these points.

In fig. 305, in order to save space and avoid confusion, only one half the outline of the section is represented.

(TO BE CONTINUED.)

# Manufactures.

## A New Hand-Car.

THERE is no doubt that within the past few years greater attention has been paid to the smaller devices connected with the maintenance of way department than ever before. On most roads economy has been made necessary by the prevailing conditions of railroad operation, and the effort has been to reduce the number of men required in every direction as much as possible. The average section gang on a railroad is now much smaller than it used to be, and it is consequently an object to reduce as much as possible the work which they are obliged to do. One of the principal tools of a section gang is the hand-car. The weight of this was not a particular object when the gang consisted of from 8 to 12 men, but when it was reduced to half that number, to find a car which

Fig. 2.

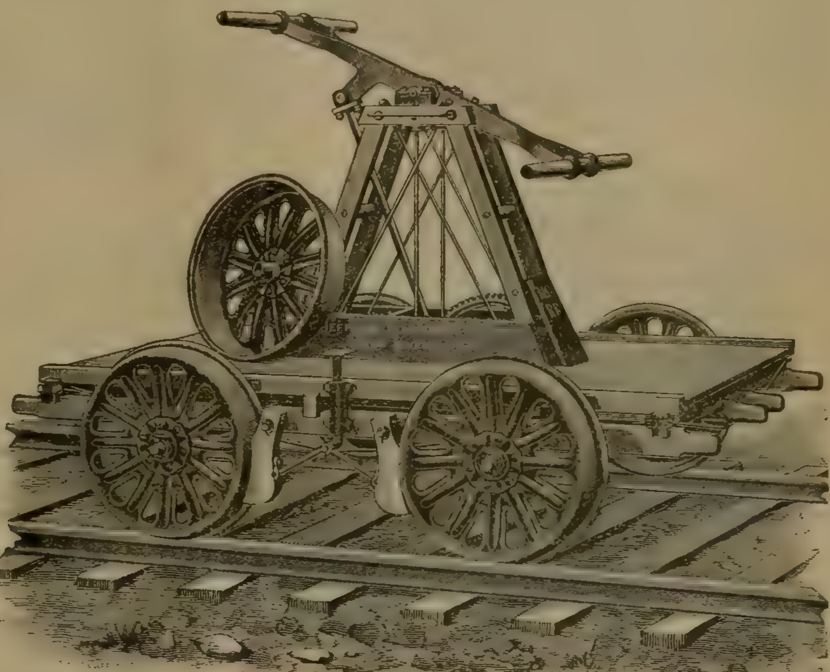


Fig. 1.

THE SHEFFIELD HAND-CAR AND STEEL WHEEL.

can be easily handled by two or three men was certainly an object. The accompanying illustration shows a car which has been built to meet these conditions ; to furnish one which can carry all that is usually necessary and at the same time can be easily lifted from the track by one or two men when it is necessary to remove it.

The greatest problem in the construction of such a car is to get a light and durable wheel. A cast-iron wheel is too heavy. The wheel with cast hub and rim and wrought spokes is not usually durable, the spokes very soon getting loose. A wood-center wheel has been tried and proved to be satisfactory, but is regarded by some railroad officers as not as strong or as durable as one entirely of metal. The wheel which is shown in perspective in the view of the hand-car and in section in fig. 2 is made from a circular plate of steel, which is brought to the desired shape by a series of operations. It is furnished with a turn-over flange, making a flange of sufficient thickness to run over and through furnaces and switches safely. It is cut away in the center after having corrugated, the corrugations adding to its strength and the cutting away reducing the weight. The hub and flange are of drop-forged steel, and are riveted to the center. The wheel appears to be strong and at the same time light, and to have the qualities required in a hand-car wheel, while at the same time it is free from the objections which have been mentioned above, and from those which have been brought forward against the wood-center wheel. Of course, it would be well adapted not only to hand-cars but for other kinds of light work, such as contractors' cars, mine cars, and similar vehicles. It may be noted, at the same time, that this wheel and the processes by which it is manufactured are a good illustration of the progress which has been made in recent years in the methods of forming and shaping steel.

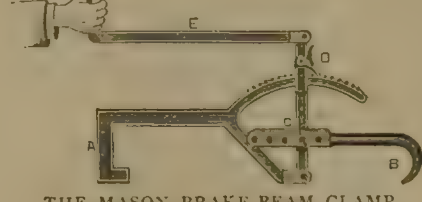
This hand-car and wheel are made by the Sheffield Velocipede Car Company of Three Rivers, Mich., whose work of this class is well known.

## Belts and Dressings.

BELTS should be cleaned regularly, and after cleaning, a good belt-dressing should be applied to keep the belt soft and elastic, and cause it to hug the pulley and transmit its greatest power. The use of a good belt-dressing is superior in economy to any other method for correcting a slipping or slightly loose belt. The custom of tightening a belt whenever it slips is not a good one. The belt is liable to be made too tight, which heats the bearings and strains the belt. Great care, however, should be taken in selecting a belt-dressing. Castor-oil is an article in very general use, but experts have found that it contains an active acid principle, and is drying in its nature. The use of soap, rosin, tar, etc., cannot too strongly be condemned. They are only temporary stimulants, and eventually destroy the belt. A belt-dressing that is guaranteed to prevent slipping, and at the same time keep the leather soft and elastic, is certainly worthy of careful consideration. Such is one made by the Joseph Dixon Crucible Company, Jersey City, N. J. There is no trouble in applying it, and all who have used it commend it in the highest terms.

## The Mason Brake-Beam Clamp.

THE accompanying illustration shows a very convenient device which has just been brought forward by the Mason Regulator Company of Boston. All trainmen know that it frequently happens on the road that the connecting-rod to the brake-beam breaks, and that it is necessary to draw the brake-beam toward the wheel in order to adjust the new rod ; the same




THE MASON BRAKE-BEAM CLAMP.

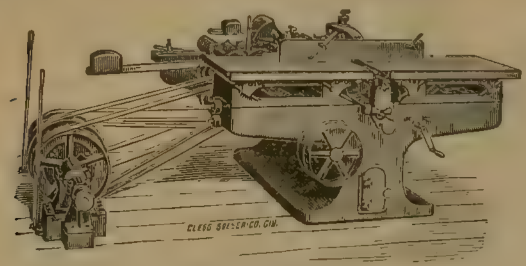
thing frequently has to be done to put a new brake-shoe upon the beam. The ordinary method is to use a screw-clamp, which is a very slow process. With the new device the beam can be instantly brought toward the truck. The hook $B$ is passed over the car axle while the other end at $A$ is passed over the

brake-beam. The beam is then pulled forward by the handle *E*, acting upon the lever *C*, the latter being held in place by the ratchet *D*; the whole forming a very convenient and cheap device.

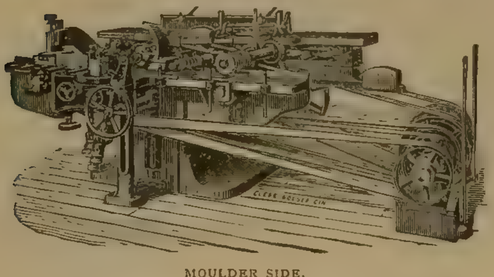
## A Compound Universal Wood-Worker and Moulder.

THE accompanying illustrations show a very complete machine which has just been brought forward by the Egan Company, and which combines several improvements resulting from long experience in the manufacture of similar machines.

These two machines, a 9-in. universal wood-worker and an 8-in. four-sided moulder, are on one frame, cast in one piece. They are driven by a patent combined countershaft, which has no loose pulley, and which requires but one belt from the line shaft, thus obviating the shifting of a belt to start or stop either machine. The arrangement of the countershaft is such that each machine is as independent of the other as if they were entirely separate. Both machines can be run at one and the same time, or each independently at different times; all adjustments can be made; heads and bits can be put on or taken off; and they can be stopped, started and operated without the one interfering with the other in the least. It answers the purpose and does the work of two separate machines, and occupies but little more space, if any, than either a separate wood-worker or a separate moulder.



WOOD-WORKER SIDE.



MOULDER SIDE.

COMBINED UNIVERSAL WOOD-WORKER AND MOULDER,

*With Patent Combined Countershaft*

The wood-worker side consists of a 9-in. universal or variety wood-worker, and has all the adjustments of an independent machine. The mandrel is made of steel, and runs in the patent journal box and slide, by means of which the mandrel has a lateral adjustment across the machine; this will be found very convenient in gaining, grooving, rabbeting and similar work, as it enables the operator, by a few turns of the hand-wheel, to put the head to the exact place wanted, dispensing with adjusting the fence to an accurate line, which is difficult to do. The patent outside bearing can be instantly removed to facilitate the changes of heads. The tables are long, and have a variety of adjustments which are easily accomplished. The tables raise and lower on inclines; both can be raised or lowered together separately; they can be raised or lowered with the circle of the head, or vertically, and each table can be moved horizontally to or from the head. All these adjustments are made from the working end of the machine. The patent bevel fence is made to adjust to positions suitable for all kinds of squaring up, beveling, cornering, etc. It is furnished with posts and springs to hold down the stock when necessary, and it can be placed so as to use the full width of the knife.

The moulder side comprises a four-sided moulder, as complete in every respect, and as available as a separate machine. Three sizes are made: 8 in. 9 in. or 10 in. The bed is gibbed to the main column, working in planed ways, and is adjusted by the large hand-wheel in front. An improved clamping device is provided to firmly clamp the outside bearing and bed to the main column, holding them solid and rigid. The cutter heads are steel slotted on four sides. The two side heads and lower head raise and lower with the bed. Each side head has a lateral adjustment, and can also be beveled. All four heads have a horizontal adjustment by means of the hand wheels in front.

The feed is powerful, and consists of four geared feed-rolls, two above and two in the bed, not shown in cut; the latter are driven by expansion gearing, and the former are arranged to lift parallel; this allows the full surface of the feed-rolls to rest across the board, although it may vary in thickness. The outside bearing to the main head is bolted to the frame and reaches to the floor, and is clamped to the bed. The adjustable box can be removed instantly when a change of heads is desired.

The variety of work that can be accomplished with this combined machine, the ease with which they can be operated together or separately, and the small amount of floor space occupied in proportion to the work that can be done, makes it a valuable tool for a wood-working establishment. It will make all kinds of mouldings, either straight, circular or wave; flooring, ceiling or partition stuff; will do rabbeting, gaining, panel-raising, jointing, ripping, cross-cutting, and a great variety of other work.

Further information about this combined machine can be obtained from the manufacturers, the Egan Company, whose address is Nos. 194–214 West Front Street, Cincinnati, O.

## Baltimore Notes.

THE Baltimore & Lehigh Railroad, now 3 ft. gauge, is to be widened to standard gauge. The work on same will begin on September 1, and will be pushed to an early completion, so as to be in a position to interchange traffic with the Baltimore & Ohio upon the completion of the Belt Road.

VICE-PRESIDENT Thomas M. King, of the Baltimore & Ohio Railroad Company, says the through east and west trains will run by way of Connellsville, Pittsburgh Division, in August, and *via* Pittsburgh from Baltimore over the Pittsburgh & Western to Akron, O. At this point connection will be made with the Baltimore & Ohio's Chicago Division by means of the Akron & Chicago Junction Railroad.

AN unusual incident happened recently on the Baltimore & Ohio. An express train was running east early in the morning, and in the forward part of the train was an express car loaded with horses. One of the animals either objected to the rapid rate at which the train was running, or else it desired to give the order for its breakfast, for it raised its head, and taking the cord of the air signal in its mouth, pulled the signal on the engine, causing the engineer to stop the train, and thereby bringing numerous heads out of the windows, to see if something was on the track or off the track, as it was not a stopping place.

THE Baltimore & Ohio is arranging for the construction of six first-class 52-ft. express cars, to be built by the Pullman Company, with stationary safes.

THE Baltimore Electrical Works Company, incorporated some time since, and located at Canton, Baltimore, has its entire plant under roof, is putting in the machines, and expects to have the entire plant in operation by fall. It is the purpose of the Company to manufacture electric machines and appliances of every character.

THE Baltimore & Ohio is constructing several miles of new track, which, when completed, will be known as the New Cut-Off, and will begin at the point of intersection of the Baltimore & Ohio and the Baltimore & Potomac, about three miles east of Relay Station, and run to a point on the Washington Branch between Elkridge Landing and Annapolis Junction. By this additional track the Baltimore & Ohio expects to reduce the time of the New York trains about ten minutes. Messrs. Ryan & McDonald, contractors of the Belt Line Road, have arranged to use the dirt from the Howard Street tunnel for filling on the New Cut-off, and will load the same in cars at Camden Station by means of an overhead railway.

THE Maryland Central Railroad Company and the York & Peach Bottom Railroad Company have consolidated under the title of the Baltimore & Lehigh Railroad Company, and instructions have been issued to have the equipment of the two roads lettered accordingly. It is not yet known whether there will be any change in the management.

THE Baltimore & Ohio's Continental Fast Freight Line will soon be put into operation. The trains for this service will consist of special box and gondola cars, equipped with automatic brakes and couplers. The engines with which the trains will be hauled are equipped with Westinghouse air brake, including the American driver brake.

THE South Baltimore Car Works, Curtis Bay, have arranged with the Baltimore & Ohio to handle 150 thorough repair cars per month.

## The Servé Ribbed Boiler Tubes.

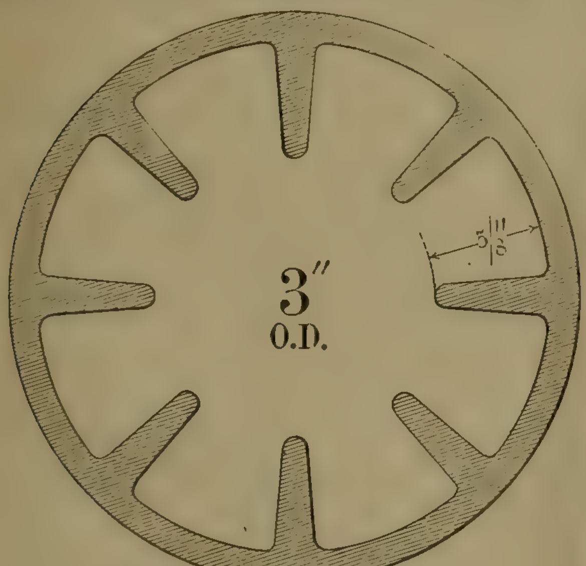
The table below gives in condensed form the result of comparative trials of these tubes, made recently at the shops of the Samuel L. Moore & Sons Company, in Elizabeth, N. J.

The boiler used was an upright tubular of the usual pattern, 42 in. diameter, with 36 in. furnace, 24 in. high, and 63 tubes 2¼ in. in diameter and 6 ft. long; 7 sq. ft. grate surface, 287 sq. ft. heating surface. It was run for six days with plain tubes, and then for six days with Servé ribbed tubes.

| Pounds of Coal per 100 Pounds of Water Evaporated. | | | Economy of coal p.c. | Increase in steam generated |
|---|---|---|---|---|
| Draft. | Plain tubes. | Ribbed tubes. | | |
| Natural draft ⅛ | 19.72 | 13.65 | 30.83 p.c. | 18.03 p.c. |
| Forced draft ⅛ | 16.7 | 13.21 | 21.08 p.c. | 30 97 p.c. |
| Forced draft ⅞ | 21.37 | 14.8 | 30.74 p.c. | 46.46 p.c. |

| Increase by Servé tubes over plain tubes. | Total evaporation. | Evaporation per lbs. of combus'n. | Extreme evaporation. |
|---|---|---|---|
| Natural draft ⅛ | 18.03 p.c. | 57.54 p.c. | 8,560 lbs. for plain tube. |
| Forced draft ⅛ | 30.97 p.c. | 32 68 p.c. | 14,000 lbs. for ribbed tubes. |
| Forced draft ⅞ | 46.46 p.c. | 46.84 p.c. | Increase 65.5 per ct. |

Each day's trial lasted 8 hours; 32.35 lbs. of wood and 150 lbs. of coal were used to start the fire and to raise steam to 70 lbs. pressure, after which the trial immediately commenced. Steam was kept at 70 lbs. pressure, and the water level at 7 in. in the glass as nearly as possible, and both were at these points at the end of the trial. In the last day's trial alone, steam was




SERVÉ'S RIBBED BOILER TUBE.

kept at about 100 lbs. pressure in order to obtain the high draft and dry steam. The water level was also about 3 in. in the glass.

The soot scraped out of the plain tubes after the six days' trial was 2½ lbs. That scraped from the Servé tubes after the six days' trial was 3 lbs.

The accompanying illustration is a section of one of the ribbed tubes. They were first illustrated and described in the Journal some time ago.

## A New Water Lift.

An arrangement for filling water-tanks for railroad or other purposes has recently been invented by Messrs. Burt and John W. Skilton of Jacksonville, Fla. It is especially adapted for the use of railroads where the motive power is always at hand, and can be used wherever there is a pond or well near the tank. A tank with a bucket containing any desired quantity of water—for service from 1,500 to 2,000 galls. would be most convenient—is made, which can be lowered into the well. The hoisting apparatus by which this bucket is raised is so arranged that a rope can be attached to a locomotive and by running the engine from 200 to 400 ft. along the track, according to the depth of the well, the bucket can be lifted to the level of the stationary tank, when its outlet is automatically opened and the water is allowed to run into the tank. The bucket is then automatically detached from the hoisting rope and falls back into the well, the rate of speed in its fall being regulated by a governor, which is placed upon the ground, and can be attached to the rope holding the bucket.

This apparatus seems to be especially adapted for the use of railroads at stations where it is not convenient to maintain a pumping engine, as a train stopping to water can fill the tank in a very short time, and the expense of maintaining the engine and keeping a man to operate it can be avoided.

This apparatus is to be introduced on several lines in Florida, and will be manufactured by the Acme Water Lift Company of Jacksonville.

## General Notes.

The Baltimore & Ohio Railroad Company has contracted for 40 passenger coaches, to be built by Pullman's Palace Car Company. The cars are to be 48 ft. 6 in. long over end sills. It is understood that part of them will be built at Pullman and some at the Detroit shops.

The Consolidated Car Heating Company has established a new department in its business, to be known as the Equipping Department, and it will be under the charge of Mr. J. H. Sewall, as Superintendent of Equipment, with headquarters in Chicago. He will have charge of the application of all the company's appliances on cars throughout the United States and Canada.

One of the largest sailing vessels ever built on the Delaware was launched from the yard of the Jackson & Sharp Manufacturing Company at Wilmington, Del., June 20. This ship is 180 ft. length of keel, 40 ft. beam, and 17 ft. depth of hold. She will have four masts, with a fore-and-aft rig. The masts will be each 97 ft. long and the topmasts 52 ft. long, making the entire length 149 ft. The bowsprit will be 47 ft. in length, and the total sail area will be about 5,000 sq. yds. of canvas. The vessel has steam hoisting engines, and the anchor, sails and cargo will be handled entirely by steam.

The Wason Manufacturing Company, Springfield, Mass., is building 10 passenger cars for the Boston & Maine Railroad to be used in suburban service. They are smaller than the usual car, being only 40 ft. in length, and will have seats for 48 passengers. The cars will weigh 30,000 lbs., and will be handsomely finished. They will be arranged with 16 longitudinal seats at each end, eight on a side, and in the middle three cross-seats of the usual pattern, the general arrangement being very similar to the cars on the New York Elevated Road.

We are informed that in the case of the Dunham Manufacturing Company—now the Q. & C. Company—against the Coburn Trolley Track Manufacturing Company, in the United States Circuit Court for Massachusetts, a final decree and permanent injunction has been granted against the Coburn Company for infringement of patent.

The firm of Gordon, Strobel & Laureau, Limited, of Philadelphia, has become the Philadelphia Engineering Works, Limited. It has added to the business of the old firm a special department for the manufacture of high-class Corliss engines of all types, and high-speed traveling cranes driven by rope, square shaft or electrical transmission of power.

The Pennsylvania Steel Company's Sparrow's Point, Md., branch has been reorganized under the name of the Maryland Steel Company, and has secured a charter in that State. Mr. F. W. Wood, General Manager of the Pennsylvania Steel Company, was made the President of the new company. The change was made in order to facilitate the transaction of business, it having been found desirable to operate under a charter received from the State in which the plant is located.

In the United States Circuit Court at Cleveland, O., the second application of the Pittsburgh Reduction Company for an injunction to prevent the Cowles Electric Smelting & Aluminum Company from manufacturing aluminum has been refused. This is regarded as a decided victory for the Cowles Company.

The National Tube Works Company of McKeesport, Pa., which is chiefly owned in Boston, is to be reorganized. A new company is to be organized under the laws of New Jersey

which will also include the Monongahela Furnace Company, the Republican Iron Works, and the Boston Iron and Steel Company, allied concerns with the same ownership. The new company will have a capital of $11,500,000. The concerns have always been very prosperous, doing a large business.

THE Richmond Locomotive Works, Richmond, Va., are building 10 ten-wheel locomotives, with 19 × 24-in. cylinders, for the Chesapeake & Ohio; 4 eight-wheel engines, with 18 × 24-in. cylinders, for the Seaboard Air Line; 2 eight-wheel passenger engines with 18 × 24-in. cylinders; 7 ten-wheel engines with 17 × 24-in. cylinders, and one switching engine with 17 × 24-in. cylinders for the Louisville Southern; 2 eight-wheel engines for the Wilmington, Onslow & Carolina Railroad.

THE contract for a steel steamer to be used in New York Harbor by the Quartermaster's Department of the army has been let to John H. Dialogue, Camden, N. J., for $57,000. This vessel will be 132 ft. long, and will be propelled by twin screws. The engines will be compound, with cylinders 14 in. and 26 in. in diameter and 18 in. stroke. Steam will be supplied by two boilers 7 ft. 7¾ in. in diameter and 17 ft. long, built to carry 110 lbs. pressure.

THE Allegheny County Light Company in Pittsburgh now has 19 Westinghouse engines running dynamos in its three electric light stations. In Station A there are three 18 × 16 standard, three 8½ × 8 standard, and four 14 and 24 × 16 compound engines; in Station B three 18 and 30 × 16 ompound, two 15½ × 14 standard, and two 13½ × 12 standard; in Station C one 14 and 24 × 14 compound and one 13½ × 12 standard engine. These 19 engines are rated altogether at 3,605 H.P. The only other engine used by the Company is a 500-H.P. Corliss.

THE St. Charles Car Company, St. Charles, Mo., has just completed a number of provision cars for the Armour Company, and is working on orders for 250 box cars for the Wabash; 200 cars for the Iowa Central; 500 cars for the Mexican National, and 500 coal cars for the Choctaw Coal & Railroad Company. The Company has just completed a very handsome passenger train for the St. Louis, Hannibal & Keokuk Railroad, consisting of baggage car, smoking car and two chair cars; the latter are fitted with Scarritt-Forney seats, and the whole train has the latest improvements in heating, lighting, etc. Two chair cars, with Scarritt reclining chairs, and three sleeping-cars are also nearly finished.

IN the new Pennsylvania Railroad Shops at Altoona, a special type of locomotive boiler is used, so modified as to adapt it to the use of a mechanical stoker. The Roney stoker is used here, and in connection with it is a complete plant of machinery for handling coal and ashes, so that the labor in the fire-room is very small. In arranging the engine plant the principle of subdivided power has been adopted throughout, and there are in the shops 17 engines, all of the Westinghouse pattern, as follows: Two 15-H.P., one 25-H.P., and two 50-H.P. Westinghouse junior engines; two 5-H.P., one 25-H.P., and one 35-H.P. Westinghouse standard engines; three 35-H.P., three 65-H.P., and two 80-H.P. compound engines. Steam loops and separators are used wherever necessary to protect the engine and economize fuel. The contract for the entire power and plant was taken by Westinghouse, Church, Kerr & Company.

THE contract for the new cable driving plant for the Brooklyn Bridge has been awarded to the Robert Poole & Sons Company, of Baltimore. The amount of the contract is $69,143.

## PERSONALS.

G. L. NICHOLSON is now Engineer and Superintendent of the Chesapeake & Ohio Canal.

J. F. BOYD is now Superintendent of the Montalto Railroad, succeeding the late COLONEL GEORGE B. WIESTLING.

N. O. DUERR, formerly with Messrs. Cofrode & Saylor, is now in charge of the office of the Toledo Bridge Company.

W. J. WILCOX is now Master Mechanic of the Charleston, Cincinnati & Chicago Railroad, with office at Blacksburg, S. C.

W. G. CHOATE is appointed Superintendent of the Rio Grande Junction Railway, in place of THOMAS SAUNDERS, who has resigned.

W. F. DURAND, late of the Agricultural College of Michigan, is now Professor of Mechanical Engineering at Pardue University, Lafayette, Ind.

E. HANDY has been appointed Chief Engineer of the Lake Shore & Michigan Southern Railroad, in place of G. H. KIMBALL, who has resigned.

WILLIAM E. SIMONDS, of Connecticut, has been appointed Commissioner of Patents by the President, to succeed CHARLES E. MITCHELL, who has resigned.

ALBERT N. CONNETT has been appointed Chief Engineer of the Baltimore City Passenger Railroad. He was recently in charge of construction of part of the Broadway cable road in New York.

W. G. WILLIAMSON, late of Montgomery, Ala., is now Assistant Engineer in charge of the Elk River Division of the Mussel Shoals Improvement on the Tennessee River. His headquarters are at Wheeler, Ala.

GEORGE B. BURBANK is now Resident Consulting Engineer to the Cataract Construction Company, which is building the water-power tunnel at Niagara. He was recently connected with the Croton Aqueduct in New York.

FRANK L. NASON, recently connected with the New Jersey Geological Survey, has been appointed Assistant Geologist of the Missouri Geological Survey, and will have especial charge of the examination of the iron ores of the State.

PROFESSOR A. T. WOODS, well known as a writer on mechanical topics, has resigned the professorship of mechanical engineering in the Illinois State University to become Professor of Dynamic Engineering in Washington University at St. Louis.

H. F. PERLEY, Chief Engineer of the Department of Public Works of the Dominion of Canada, has been suspended from office until charges made against him can be investigated. The charges are that he permitted his wife to receive valuable presents from a contractor.

M. L. HINMAN, Treasurer of the Brooks Locomotive Works, has been chosen President o the Lake Shore Bank at Dunkirk, N. Y. Mr. Hinman has frequently been called upon to hold positions of trust, and this election is another instance of the esteem in which he is held at home.

COLONEL V. E. MCBEE has been appointed General Superintendent of the Central Railroad of Georgia. He is a railroad officer of much experience. R. R. BRIDGERS, JR., succeeds Colonel McBee as Superintendent of the Western North Carolina Division of the Richmond & Danville Railroad.

JAMES K. GEDDES has been appointed General Manager of the Bellaire, Zanesville & Cincinnati Railroad in place of W. R. CRUMPTON, who has gone to the Baltimore & Lehigh Railroad as General Manager. Mr. Geddes will continue Chief Engineer of the road, and will retain his office at Zanesville, Ohio.

PROFESSOR MARK W. HARRINGTON has been appointed Chief of the Weather Bureau, which on July 1 was transferred from the War to the Agricultural Department. Professor Harrington is well known as a meteorologist, and has been for some years past connected with the University of Michigan.

ASSISTANT NAVAL CONSTRUCTORS JOHN G. TAWRESEY and WILLIAM VANSANT, who were sent by the Navy Department to the School of Naval Architecture at Greenwich, England, have graduated. Mr. Vansant stood No. 1 and Mr. Tawresey No. 5 in the class, which consisted of 50 officers from the English and other services.

NAVAL CADETS HENRY G. SMITH, HORATIO G. GILMER, RICHARD M. WATT, and LAWRENCE SPEAR have been ordered to duty in the Construction Department—Cadets Smith and Gilmer at the New York Navy Yard, Cadets Watt and Spear at the Norfolk Yard. It is understood that they will shortly be sent abroad to take a special course in naval architecture.

WILLIAM HAMILTON HALL, formerly State Engineer, has been selected by the State Association of Irrigating Districts of California as Consulting Engineer to report on questions of water supply and irrigation, and to supervise the work of the district engineers. Mr. Hall is well qualified for this work by experience, and by his familiarity both with the general question of irrigation and its special applications in California.

CHAUNCEY SMITH, of Cambridge, was appointed Railroad Commissioner of Massachusetts in place of GEORGE C. CROCKER, whose term has expired. Mr. Smith is one of the most eminent patent lawyers in the country, has a thorough knowledge of all mechanical and electrical matters, has taken an active interest in and made a close study of public and social questions. The Executive Council, however, failed to confirm the Governor's appointment, and Mr. Crocker holds over.

## OBITUARY.

PROFESSOR GEORGE M. MOWBRAY, who died at North Adams, Mass., June 21, aged 66 years, was a high authority on the use of explosives in engineering work. He was specially well known from the fact that he manufactured the explosives used in the construction of the Hoosac Tunnel.

GEORGE G. HALSTEAD, who died in Paterson, N. J., July 12, aged 45 years, was for nearly 25 years a surveyor, and for years past had been regarded as final authority on boundaries and land titles in Passaic County, and indeed all through the northern part of New Jersey. Few men have had a more thorough knowledge of land surveying and local history.

SAMUEL H. KETTLEWELL, who died recently in Baltimore, was an engineer of considerable experience. He was topographical engineer to the commission which laid down the boundary line between Mexico and the United States about 1850. Later he was employed in surveys made for a canal across the Isthmus of Darien. During the late war he was topographical engineer in the Army of Northern Virginia in the Confederate service.

COLONEL GEORGE B. WIESTLING, who died at Montalto Park, Pa., June 15, aged 56 years, was for a number of years employed on the Pennsylvania Railroad as a civil engineer. Later he was on the Delaware, Lackawanna & Western, and built the long tunnel near Oxford Furnace, N. J. He served with distinction during the War as an officer of artillery. For some years past he has been Superintendent of the Montalto Railroad and President of the Montalto Iron Company.

RICHARD POILLON, who died in New York, July 4, aged 73 years, was an old and successful shipbuilder. He learned the business from his father and conducted it for many years, at first with his brother and later with his son. During the war Poillon Brothers built several vessels for the Government, and about 1872 they built two war-ships for Japan, the first modern vessels of the Japanese Navy. Of late years the firm was chiefly engaged in building yachts, and their yards turned out the *Sappho*, the *Dreadnaught*, and several others famous for speed.

WILLIAM GUSTAVUS WALLER, who died in Baton Rouge, La., June 13, aged 78 years, was born near Schenectady, N. Y. He early became an engineer, and was for a time in government service; later he was employed on the Philadelphia & Reading, and afterward on several railroads in Virginia. He went to Louisiana about 1843, and for many years was a leading civil engineer and surveyor in that State. For many years he kept full and accurate accounts of the state of the Mississippi, and his reports have been frequently quoted and referred to as authority.

GENERAL ALBERT G. BLANCHARD, who died in New Orleans, June 21, aged 81 years, graduated from West Point in 1829, and served in the Army until 1840, when he resigned and settled in New Orleans. He returned to the Army later, and served during the Mexican War. Later he made all the surveys for the old New Orleans, Opelousas & Great Western Railroad, and for several other projected lines. During the late war he served in the Confederate Army, rising to the rank of brigadier-general. Since the war he has been employed as consulting engineer for several important enterprises.

CHARLES ALBERT FESTETICS, who died in Jersey City, N. J., June 25, aged 51 years, was born in Hungary, and served for a time in the Austrian Army. He came to this country in 1866, and was for a time Assistant to General C. P. Stone in the surveys for the Florida Ship Canal. Subsequently he was Constructing Engineer of the Texas & Pacific Railroad. For several years he was on the New York Central & Hudson River, and had charge of the building of the third and fourth tracks between Albany and Buffalo. For several years he was with the Cornell Iron Works in New York. At the time of his death he was Chief Engineer of the Alabama Coal & Iron Company.

EDWARD BURGESS, who died in Boston, July 12, aged 43 years, was born in West Sandwich, Mass., graduated from Harvard College, and was for a short time employed as an instructor there. In 1873 he began a remarkable career as a designer of yachts, and entered into business as a naval architect in Boston. He soon became famous for his fast boats, and over 100 of the most noted American yachts have been built on his designs, including such boats as the *Sachem*, the *Wraith*, the *Titania*, and the three famous flyers, the *Puritan*, *Mayflower* and *Volunteer*. Mr. Burgess served in 1887 as a member of the Naval Board to award prizes for designs of cruisers and battle-ships, and for three years past had been a member of the Board on Life-Saving Appliances in the United States service.

## PROCEEDINGS OF SOCIETIES.

**New England Roadmasters' Association.**—The ninth annual meeting of this Association will be held in Boston, August 19 and 20.

Committees have been appointed to report upon the following questions:

1. Track Joints; trouble experienced with joints now in use, and points which new ones should cover.
2. Fences, Cattle Guards, and Railroad Crossings.
3. Best Method of Securing Rails to Ties outside of Joints; Holding gauge on curves, spikes, braces, plates, etc.
4. To what Extent can Wear on Locomotive Driving-Wheel Tires be allowed before general economy demands that they should be repaired?

**International Congress of Geologists.**—The Fifth International Geological Congress will be held in Washington, August 26, and the Committee on Organization has already arranged the details. The meetings will be held in the rooms of the Columbian University, where sufficient room has been set aside for this purpose.

The meetings of the American Association for the Advancement of Science, and of the Geological Society of America, which will take place during the week preceding that of the meeting of the congress, will be held in the same building. The daily programme of the several meetings is as follows:

Aug. 19 to 22.—Meetings of the various sections of the American Association for the Advancement of Science. The foreign members of the congress have been made honorary associate members of the association by its council, and are thereby entitled to take part in its geological and archæological excursions in the vicinity of Washington, and to avail themselves of the reduced rates of fare on railroads which are accorded to its members. American members of the congress who are not already members of the association are invited to join it at the present meeting.

Aug. 24 and 25.—Meetings of the Geological Society of America. The foreign members of the congress are likewise invited to attend the meetings of this society, to contribute papers, and to take part in the present meeting.

Aug. 26 to Sept. 2.—Meetings of the International Congress of Geologists.

Besides the regular subjects of discussion, such as unfinished business of the former congress, reports of committees, etc., the Committee on Organization recommends that the following subjects be made special topics for the consideration of the congress at this meeting: (I) Time correlation of the plastic rocks; (1) correlation by structural data; (*a*) by stratigraphical data, (*b*) by lithological data, (*c*) by physiographical data; (2) correlation by paleontological data; (*a*) by fossil plants, (*b*) by fossil animals; or (*a*) by marine fossils, (*b*) by terrestrial fossils: (II) General geological color schemes and other graphic conventions: (III) Genetic classification of the pleistocene rocks.

The Committee has arranged for several excursions to take place after the meeting, in which those attending the Congress, whether from this country or from foreign countries, can take part. A long excursion which will occupy about twenty-five days will enable visitors to see the best scenery and most interesting geological phenomena in the Eastern States, the Mississippi Valley and the Rocky Mountain region, concluding with a week in the Yellowstone National Park. Should sufficient members join, shorter excursions will be made through the South Appalachian region, the copper and iron regions of Lake Superior, and through the oil region of Pennsylvania to Niagara Falls and thence down the St. Lawrence to Montreal and Quebec.

**Master Car-Builders' Association.**—A circular from Secretary John W. Cloud submits to letter-ballot the various questions which were so referred at the recent convention. They are as follows:

*A*. On the recommendations made by the Committee on Lettering Freight Cars as to standard practice.

*B*. On the system of Joint Inspection, the form of Joint In-

spection Agreement, and the rules governing Joint Car Inspection as reported by the Committee.

*C.* On the form of report of Defective Cars received and delivered which was proposed by the Committee.

*D.* On the form of Joint Inspection Defect Card proposed by the Committee.

*E.* On the proposed change of the standard size of pin in the Air-brake Standards of the Association from $1\frac{7}{64}$ in. to $1\frac{3}{32}$ in. in diameter.

*F.* On rescinding the action of the Association in adopting the Fletcher journal-box lid as a standard.

*G.* On the adoption of the journal-box, bearing, wedge and lid for 60,000 lbs. cars as submitted by the Committee.

*H.* On the modification of the old standard Journal-box to receive a lid similar to that proposed for the Journal-box for 60,000 lbs. cars, and the adoption of that lid as a standard.

The votes will be counted on September 2 next, and ballots received after that date will not be admitted.

The Secretary also announces that the Revised Rules of Interchange are now ready for distribution.

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**Boston Society of Civil Engineers.**—At the regular May meeting, in Boston, Mass., James B. Francis and Samuel Nott were chosen honorary members. The following gentlemen were elected active members: William E. Baker, James T. Boyd, Benjamin G. Buttolph, Percy N. Kenway, J. W. Linzee, Jr., and Franklin C. Prindle, Boston; Heywood S. French, Newtonville, Mass.; Lewis J. Johnson, Cambridge, Mass.; Herbert F. Pierce, West Newton, Mass.; Edward W. Shedd, Worcester, Mass.

Mr. C. H. Van Orden presented a paper on the Town Boundary Survey of Massachusetts, which was discussed. Mr. L. M. Hastings read a paper on Problems in City Engineering, which also called out some discussion. Mr. Fitzgerald made a few remarks on the cost and construction of Basin V of the Boston Water Works at Ashland, Mass. The members had visited this work in the afternoon before the meeting.

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At the regular meeting in Boston, June 17, the following members were elected: Luther Deane, Taunton, Mass.; Edward Lyman, Lowell, Mass.; Charles T. Main, Lawrence, Mass.; H. J. Morrison, Cambridgeport, Mass.; C. G. Nevers, Frank E. Sherry, Boston, Mass.

Mr. Allen Hazen read a paper on the Mechanical Precipitation of Sewage, giving an account of the experiments made at the station at Lawrence. He stated that there are two ways of purifying sewage; first, by separating the impurities and then removing them; and second by destroying the impurities by chemical means. As to which is to be preferred depends very much upon local conditions. This subject was discussed at considerable length, reference being made to the importance of a constant examination of the character of the sewage to determine the method which could best be used.

Previous to the meeting the Society had an excursion to Lowell, where members inspected the carpet mills, the Merrimac Mills, the locks and canals, etc.

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**New York Railroad Club.**—At the regular meeting in New York, May 21, which was the last meeting of the season, Mr. W. F. Ellis read a paper on Frogs and Switches, calling attention to recent improvements made, and the importance of these parts of the track, especially in view of the increase in weight of engines and speed of trains. The paper was discussed by Messrs. Mitchell, Forney, Ellis, and others.

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**Engineers' Club of Philadelphia.**—The regular meeting of May 16 was devoted to the discussion of Rapid Transit for Philadelphia. Papers were presented by John L. Gill, Jr., and S. L. Smedley on the general question; by G. H. Condict, T. Carpenter Smith, and P. G. Salom on electric railroads. All these were discussed by members present. An elevated line on Market Street seemed to be approved.

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At the regular meeting, June 6, the Secretary presented communications relative to the Engineering Congress at Chicago in 1893.

A paper on Rail Joints, by G. W. Creighton, was read, giving results of experiments.

Professor H. W. Spangler presented a model and specimen illustrating a curious case of combined tension and flexure. The specimen in question was square in section at the ends. A few inches from each end it was enlarged on one side and still further enlarged in the middle on the same side, thus giving a much greater area of metal next to the ends, and still a greater area in the middle. The specimen, which had been broken in tension, had not been broken at the ends, but through the section next to the ends, where there was a large increase in area. Professor Spangler then presented a mathematical discussion, showing that this fracture occurred where it did in accordance with strict mathematical principles. This called out some discussion.

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**Engineers' Club of Cincinnati.**—At the regular meeting, June 18, four new members were elected.

Mr. A. S. Hobby read a very interesting paper on Brick Masonry.

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**Civil Engineers' Club of Cleveland.**—At the regular meeting, June 12, Mr. Utley Wedge was elected a member.

Mr. Walter Miller read an interesting paper on Steam Steering Gear for Lake Vessels, and illustrated with drawings the mechanism by which the greatest accuracy is obtained in turning the rudder any desired number of degrees. This was followed by a brief discussion as to the practicability of applying the same or similar arrangement to cranes and other hoisting machinery.

Professor E. P. Roberts then read an excellent paper on Considerations Governing the Choice of a Dynamo, in which the general construction of the dynamo was fully explained, and the good points that one should look for when making a choice were fully gone over. After a short discussion on this paper Mr. F. C. Osborn gave an account of the recent Convention of the American Society of Civil Engineers at Lookout Mountain. The Club then adjourned for lunch.

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**Western Society of Engineers.**—At the regular May meeting in Chicago, J. C. Slocum, W. C. D. Gillespie, William H. Hendren, Theodore W. Parvin, Morgan Walcott, and B. Thomas were elected members.

The Secretary gave some information as to the work done by the General Committee in preparation for the International Engineering Congress in 1893.

A preliminary vote was taken on the question of changing the name to the Chicago Society of Civil Engineers, the result being against the proposed change. The subject will be brought up again.

Mr. T. T. Johnston read a short note relative to Mr. Corthell's paper on the Enlarged Waterway between the Lakes and the Seaboard.

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**Engineers' Club of Minneapolis.**—The regular May meeting was the fourth joint meeting of the St. Paul & Minneapolis Clubs. President Pike of the Minneapolis Club presided. An interesting paper was read by Mr. Woodman of the St. Paul Club on Railroad Tunnels in Wisconsin. Some extracts from this were published last month. A discussion of this paper called out a number of opinions on the best way of ventilating a tunnel. The opinion was expressed that for a single track tunnel 3,800 ft. in length, the best plan yet found was to run a train through quickly and follow it up with another as closely as possible.

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At the regular meeting, June 4, the action of the Executive Committee on the International Engineering Congress and on Club headquarters was approved. Mr. Frank Llewellyn was elected a member.

Mr. O. Hoff read a paper on Bridge Erection, calling attention to the fact that details were often so designed that the erection of a bridge cost more than it ought. Couplings should have plenty of play, and field riveting be reduced to a minimum. He described some devices used in erecting, travelers especially.

**Northwestern Track & Bridge Association.**—At the May meeting in St. Paul, Mr. William McGonagle read a paper on the Best Method of Preserving Timbers, in which he described several processes adopted for this purpose, including creosote, Burnett process, kyanizing, and others, giving the results so far obtained and the cost.

The same gentleman read a paper on Covering the Members of a Howe Truss Bridge, in which he sought to prove from experience that it would be well to do so.

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**Engineering Association of the South.**—A regular meeting was held May 15, at Earlington, Ky. A communication from the Chattanooga *Tradesman* offering a cash prize of $25 for the most meritorious paper presented to the Association during the current fiscal year was received and accepted. Mr.

Gaudenz Luetscher, Ensley, Ala., and Lieutenant John Biddle, U. S. Engineers, Nashville, Tenn., were elected members.

A paper on Coal Cutting Machinery was presented by J. B. Atkinson, Vice-President of the St. Bernard Coal Company. The paper presented a historical account of the development of coal cutting machinery and a comparative study of American machines as compared with those of England and France. The use of electricity as a motive power was thoroughly discussed, and the advantages and disadvantages of the positive feed machines set forth.

During the day of the 15th a very general inspection of the collieries and coke ovens of the St. Bernard Coal Company was made, and the improved system of coal cutting machinery and hoisting machinery was carefully studied and greatly admired. The visiting members were very hospitably entertained at the residence of President and Mrs. Atkinson.

Saturday, the day following, was spent in a yachting and fishing excursion on the lake, the members leaving for their homes Saturday evening. The meeting was one of the pleasantest enjoyed by the Association.

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AT the regular meeting in Nashville, Tenn., June 11, the Board of Directors reported that permanent headquarters had been secured in the new Cumberland Publishing House on Cherry Street, Nashville, Tenn. The headquarters comprise a suite of three rooms which may be thrown into one large room 43 × 23 ft. on the second floor of this new building just nearing completion. The headquarters of the Association will be completed and in readiness for occupation before September.

Mr. Mitford C. Massie, Crossville, Tenn., was elected a member. It was decided to suspend the monthly meetings of the Association during the months of July, August, and September, holding the next meeting in the new quarters of the Association at Nashville, October 8.

Mr. J. J. Ormsbee read a paper on Mining Operations in the Sewanee Coal Seam, describing the coal-mines at Whitwell and Tracy City.

Mr. J. H. Heiskell read a paper on Street and Highway Traffic, advocating improvement in vehicles.

Mr. R. L. Johnson read a paper on Capacity of Sewer Pipe to withstand internal strains, giving the result of experiments made at Vanderbilt University, in which 8-in., 15-in. and 24-in. pipes failed at about equal pressures, the tests used ranging from 10 lbs. to 18 lbs. per square inch.

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**Atlanta Society of Civil Engineers.**—This Society has been organized at Atlanta, Ga., with the following officers: President, Grant Wilkins; Vice-Presidents, H. B. Baylor, N. W. Davis; Secretary, Parker N. Black; Treasurer, C. C. B. Haines; Directors, R. M. Clayton, B. M. Hall, W. S. Larendon. The Society will hold monthly meetings. It starts with 22 active members.

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**Denver Society of Civil Engineers.**—At the regular meeting, June 23, Mr. John S. Titcomb read a carefully prepared paper on Irrigating Canals and Ditches, which was generally discussed.

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AT the regular meeting, July 14, the subject of Irrigation was continued by a paper presented by Mr. L. G. Carpenter, on Loss of Water in Irrigation, in which he referred at length to the different causes of loss, such as evaporation, seepage, leakage, and others.

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**Technical Society of the Pacific Coast.**—At the regular June meeting a paper by Mr. Jerome Newman on Analysis of Strains in Bridges and Girders was read. It was chiefly mathematical, giving a number of rules and formulæ.

The paper on Hall's Hydro-Steam Elevator, read at the May meeting, was taken up and generally discussed by the members present.

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**American Society of Mechanical Engineers.**—The summer meeting was held in Providence, R. I., the opening session beginning on Tuesday morning, June 16. An address of welcome was made by the mayor of the city, Mr. C. S. Smith, to which President R. W. Hunt responded. At this session several papers were read, including one on Rope Haulage, by R. V. A. Norris; Belt Dynamometers, by S. P. Watt; Belt Testing Machines, by G. I. Olden; and Test of a Triple-Expansion Engine, by J. T. Henthorn.

The Committee on Standard Method of Testing Materials reported progress, and stated that the Committee of the Civil Engineers' Society was also at work upon the same subject, and the final report might be a joint one. The Committee on Standard Methods of Testing Locomotives reported progress. The Committee on Standard Units of Measurement reported some resolutions, which were not then acted upon, but were later referred to the Council for consideration.

At the evening session a number of papers were read, the most important of which were on the Economy of Simple and Compound Engines, by Professor Jacobus; Flexure of Elastic Rings, by Professor De Volson Wood; Premium Plan for Paying for Labor, by F. A. Halsey. Several of these papers were discussed.

Between the sessions on Tuesday afternoon the members visited the Nicholson File Works, Rhode Island Locomotive Works, and the shops of the Gorham Manufacturing Company.

The Wednesday morning session was devoted to the reading of papers, a large number being presented. Two of these called out considerable discussion; one being on Jet Propulsion, by Professor J. R. Webb, and the other on Steam-Engine Jackets, by Professor Thurston. An important paper also was that by W. A. Rogers on Screw Cutting and Index Wheels.

At this session there were also several topical discussions, including one on the Speed of Hot Air Engines; another on the Possible Speed of Corliss Valve Gear, and another on the question as to whether it is better to melt iron in a cupola rapidly or more slowly.

On the same day visits were paid to the works of the Harris-Corliss Engine Company, the Brown & Sharpe Manufacturing Company, and the Armington & Sims Engine Company. In the evening members attended a reception given by the citizens of Providence, which was a very pleasant occasion.

At the Thursday morning session, Mr. H. M. Howe read an important paper on Manganese Steel, which was discussed at considerable length. Professor J. E. Denton read a paper on the Performance of a Worthington High-Duty Pumping Engine, and Mr. W. R. Roney presented one on Mechanical Stokers. A topical discussion was had on Pyrometers. This closed the work of the meeting.

After adjournment, the members went down the Bay to Rocky Point by steamer, where they enjoyed a Rhode Island clam-bake. On the return trip the steamer went as far as Newport. In the evening many inspected the power station of the Narragansett Electric Lighting Company.

On Friday the works of the Corliss Engine Company, the Rhode Island Tool Company, and the Amercian Ship Windlass Company, and the pumping station of the Providence Water Works were visited, the members dispersing to their homes in the evening.

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## NOTES AND NEWS.

**Chiquecto Ship Railroad.**—The Canadian Parliament has extended the time for the completion of this work one year. In the debate over the proposed extension, it was stated that the total quantity of clay and rock excavated was 1,745,957 cubic yards, leaving 278,933 yet to be excavated. Besides this the steel rails were all delivered, nearly all the hydraulic machinery, one and one-half miles of single track laid, and nine-tenths of the heavy iron sleepers delivered. The ship cradles were ready, the locomotives are being built in Kingston, and there remains but one mile of grading to do. The reason for the delay was that the company is obliged to excavate for the basins 24 feet deeper than the estimate, in order to reach a solid rock foundation. Another cause was the scarcity of labor, owing to the railroad works in Annapolis and Cape Breton. The total expenditure thus far has been $3,000,000, leaving $2,500,000 yet to be expended in finishing the work.

**"Engineering Experience."**—Not long since, in an arbitration case, an engineer was thus examined as to his professional experience and capacity: "How long have you been in the profession?" "Twelve years." "Are you thoroughly acquainted with your work, theoretically and practically?" "Yes." "Do you feel competent to undertake large constructions?" "Yes, most certainly." "In what engineering works have you been engaged during the last twelve years?" "The manufacture of iron bedsteads."—*Toronto, Ont., Monetary Times.*

**A Swiss Railroad Accident.**—The Cologne *Gazette* of June 15 has an account of a railroad accident at Basle, Switzerland, in which an excursion train was precipitated into a river and a number of lives lost. That the entire number of passengers was not lost is due to the Westinghouse air-brake. The account says: "The unfortunate train was filled with passengers, because many people from Basle were going to visit the singing festival at Moenchenstein. The new bridge close to the station spans the river Birs, above rapidly flowing waters. The train consisted of two engines, two fast freight cars, and ten coaches. The bridge broke in two. The entire first part of the train was precipitated into the river, but six of the coaches remained on

the track, held there by the tearing apart of the couplings, which brought the Westinghouse automatic brake into action, and resisted further progress. Up to the present 65 bodies have been found; 41 seriously injured passengers are lying in the Basle Hospital. The work of clearing away the débris is being performed slowly."

**A New Boston & Maine Station.**—The designs of the new Boston & Maine Railroad station to be built at once on the north side of Summer Street, Malden, are finished. The plans indicate a main station 35 × 98 ft., and a baggage house, located south of the depot, 20 × 29 ft.

The building is designed in the romanesque style, erected so as to face the tracks, and distant 39 ft. from the same. The interior is one large waiting-room, 31 × 70 ft., the ticket-office projecting sufficiently to give an ample ladies' room at the north, and the gentlemen's room at the south. In a circular tower at the northwest corner is a ladies' private reception-

room, 18 × 26 ft., with a toilet-room. The ticket-office is circular, with a door entering into the lobby on the south, through which patrons of the road pass in entering or making their exit from the track side. There is also an entrance north of the ticket-office. In the southwest corner is the gentlemen's toilet-room, and in the southeast corner is the agent and operator's room, with entrance from the track side. Surrounding the depot is a broad concrete platform 15 ft. wide. A semicircular driveway, 21 ft wide, with two separate entrances, enables carriages to approach the depot from the west, driving under a *porte-cochere*, which has the monogram "B. & M." on its front. The depot is connected with Summer Street by a 10-ft. walk.

The foundation walls of the main station are to be of good granite block stone. The exterior walls of both buildings above the base courses will be of hard burned brick of the best quality and hardest cull. All the outside walls, as well as the interior of the *porte-cochere* lobby entrance, are to be of best selected hand-made red brick. The filling between the walls of the lobby is to be tiled. The ceilings will be of double-beaded clear whitewood sheathing, and blind nailed, and side walls and all vertical sheathing will also be of the same material.

The wainscot door and window casings, seats, base boards, etc., are to be of clear red oak. All windows and doors are to have plain wide architraves, with edges rounded. There will be whitewood cornices. The toilet-rooms will be tiled with fine white Italian marble, the lobby with Knoxville, Tenn., marble. The door of main entrance from lobby and doors between ladies' room and toilet-room and between the lobby and ticket-office are to have saddles of the same marble, suitably beveled. The toilet-rooms will have Italian white marble skirtings and plinths. The seats will be oak. There will be oak doors. The curved window of the ticket-office will be set in a framework of copper, and there will be more or less copper and wrought-iron trimmings.

South of the main station 15 ft. is the baggage house, a separate, oblong building, 17 × 26 ft., with two doors opening on the platform toward the tracks. South of this is a large open space for express wagons to drive alongside of the platform, which extends to a point near where is located the present depot.

The woodwork of the two buildings will be neatly painted or stained; and although it will be piped for gas, electricity will be the illuminating light. It will be heated by steam, and the ventilation and sanitary conditions will be of the best.

Mr. Arthur F. Gray, of Boston, is the architect, and the contract for the entire work has been awarded to Peabody & Pike. The buildings are to cost $40,000. The accompanying illustration shows this station, which is of very neat design, and harmonizes well with the surroundings.—*Boston Herald.*

**The Baltimore Cable Railroad.**—The cable road of the Baltimore Traction Company is now in full operation. It extends from Druid Hill to Patterson Parks. Four cables $1\frac{5}{16}$ in. in diameter are used, arranged as follows: A slow-speed cable from the Druid Hill engine-house to the parks, a high-speed cable from the engine-house to Paca and Fayette streets, a slow-speed cable from the same point east through the business part of city to the engine-house on Central Avenue, a high-speed cable from there to Patterson Parks. The citizens are enthusiastically in favor of rapid transit; the cars are crowded with passengers, while the almost parallel routes of horse cars on Madison and Pennsylvania Avenues are scarcely patronized. In fact, so great is the decrease of travel on the horse lines that immediate steps are being taken to cable several of these old routes.

**The East African Railroad.**—If the despatches from Berlin are correct, the German East African Company has decided to appropriate the sum of $15,000,000 to build a railroad from Tanga, a little seaport about 50 miles northwest of Zanzibar, to Karagwe, the region of which Speke and Stanley gave such glowing reports. It lies a little west of the Victoria Nyanza. The railroad, by starting at Tanga, will avoid the steep climb up the Usugara Mountains, though it will have to make a considerable ascent to reach the interior plateau. It is probable that it will extend nearly due west from Tanga to Tabora, which is the heart of the trade of inner East Africa, and will then turn north and northwest to the Victoria Nyanza and Karagwe. — *Goldthwaite's Geographical Magazine.*

**The Manchester Ship Canal.**—On June 19 water was admitted into the Manchester Ship Canal at Ellesmere Port on the Mersey, thus marking the approaching completion of this great English work. The water was admitted by a cut in the bank, the opening of the lock gates and the completion of the deep channel having yet to be carried out. There is now a depth of 26 ft. of water from Ellesmere Port to Eastham, $3\frac{1}{2}$ miles, and only a little dredging of the bottom remains to be done. The canal was to be filled with water from Eastham to the mouth of the Weaver about the end of July.

**An Unsinkable Boat.**—The accompanying illustrations, figs. 1 and 2, represent a steel boat in elevation and plan respectively, which is being introduced by Mr. W. Wells, Leith, Scotland, and which is claimed to be absolutely unsinkable and instantaneously self-righting. The fore-and-aft sections of the boat are constructed in the form of hollow cones, and are thoroughly air and water tight. These are slightly flattened and laid horizontally, and, owing to their peculiar form, impart strength and rigidity to the boat as a whole. The inventor claims that these boats are eminently suitable for pleasure purposes of every description, as they maintain their buoyancy when filled to the gunwale with water; and even if turned bottom upward they instantly right themselves. These boats

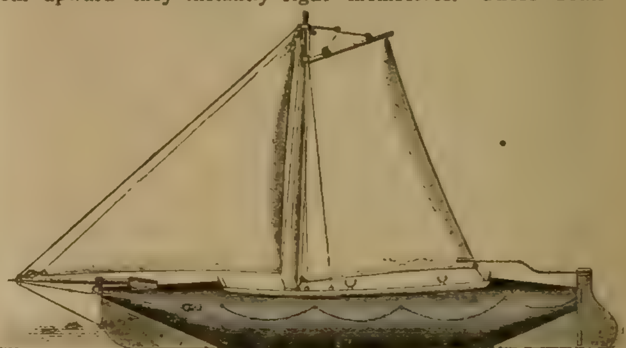

FIG. 1.—ELEVATION

FIG. 2.—PLAN

would appear to be especially suitable as an addition to the life-saving equipment of vessels, as, in case of emergency, they could be thrown overboard without the formality necessary with boat-lowering gear in use with ordinary punts or dingies, and would instantly right themselves. The boats are put together in sections, and can be disjointed for transportation, and, it is stated, that should both the water-tight compartments be pierced below the water-line, the boats would still remain buoyant. The boats are exceedingly light, one 12 ft. long and 3 ft. beam, with oars, masts, and sail, only weighing 336 lbs. We are informed that these boats have successfully undergone severe tests in the Firth of Forth.—*Industries.*

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, SEPTEMBER, 1891.

A CORRESPONDENT informs us that one of the old steam carriages for use on common roads which were described in the JOURNAL for August is still in existence, and is preserved in the Patent Museum at South Kensington, London. It is interesting to know that such a relic still exists and can be seen and studied by modern inventors.

THE advocates of the Lake Erie & Ohio River Ship Canal have suggested an argument in its favor in addition to the commercial advantages which it offers. This is that, in case of war, ships of the size of the *Yorktown* or the *Concord* could readily be passed through the canal for service on the Lakes. Moreover, war-ships of considerable size could be built at Pittsburgh, where material is abundant, and sent up to the Lakes. In this way the canal would be an important addition to the military power of the country.

FOR the first half of 1891, according to the figures collected by the American Iron & Steel Association, the production of pig iron in the United States was 3,371,925 gross tons; a decrease of 1,188,588 tons, or 26 per cent., as compared with the first half of 1890. The decline was greatest in Pennsylvania, Ohio and Illinois, the leading Northern producing States; it was less marked in the Southern iron districts. The greatest reduction also was in iron made with bituminous coal and coke, the anthracite and charcoal furnaces showing a much smaller percentage of decrease. The reduction was due partly to labor troubles in the coke districts, but probably more to the general inactivity in business which marked the early months of the year.

ACCORDING to the same authority, the production of Bessemer steel for the first half of 1891 was 1,599,096 net tons; a decrease of 442,143 tons, or 27½ per cent., from the first half of 1890. The causes for this decrease were very nearly the same as for that in pig iron, and, in fact, the two generally run in nearly parallel lines.

It is interesting to note that every year the proportion of the total steel production made into rails decreases. In the first half of 1891, of all the Bessemer steel ingots made 36½ per cent. were rolled into rails, while in the first half of 1890 the rail mills absorbed 50½ per cent. This shows the rapidly growing use of steel in construction, which we have heretofore noted from time to time.

The rail production for the half year was 579,929 tons, the smallest recorded since the first half of 1885. In fact the decrease in steel production was entirely in rails.

THE figures gathered by *Poor's Manual*, while not all that could be desired, are of much interest as making the best available showing of the general condition of the railroads of the country. A few figures from this source will show the magnitude of the railroad interest in the United States. These are for the year 1890:

| | |
|---|---|
| Miles of railroad | 163 420 |
| Miles of track, including second track, etc. | 208.303 |
| No. of locomotives | 32,241 |
| No. of passenger-train cars | 30,211 |
| No. of freight cars | 1,061,970 |
| Total train mileage | 793,925,145 |
| Passengers carried | 520,439,082 |
| Passenger-miles | 12,521,565,649 |
| Tons freight carried | 701,344,437 |
| Ton-miles | 79,192,985,125 |
| Gross earnings | $1,086,040,207 |
| Net; above working expenses | 341,666,369 |

As the total liabilities reported—stocks, bonds and floating debt—amounted to $10,393,781,120, the net earnings, or surplus over operating expenses, were last year about 3½ per cent. on the liabilities, which nominally represent the cost of the railroads. The surplus after paying interest, rentals and other fixed charges was 2.9 per cent. on the amount of stock reported.

The average earnings per passenger-mile last year were 2.185 cents, a slight increase over 1889; per ton-mile they were 0.935 cent, a slight decrease. The average gross earnings per mile of road in 1890 were $6,946, an increase of $422 over 1889, while the net earnings per mile were $2,195, an increase of $100. These gains were perhaps due to improvement in business, but in part, doubtless, to the fact that much less new mileage was included in the returns for 1890 than for several years past.

Last year was generally a good one for railroads, and in 1891 the prospect is that the closing months will almost be able to make up for the depression of the earlier part of the year.

THE manœuvres of the Squadron of Evolution have served a good purpose, not only in training the officers and crews, but also as a sort of object lesson in showing the people of the great seaboard cities the progress made in building up a new navy and in cultivating their appreciation of its excellence. It does seem, however, as if the Squadron had almost reached the limit of its usefulness in this direction, and it would be well to send the cruisers in various directions abroad, where their services are needed, and where the United States is now represented only by old and almost worn-out ships. Such a course also would show better the merits and defects of the new ships and enable us to avoid the latter in the future.

Probably the most useful ships in time of peace will be the cruisers of the 2,000 and 3,000-ton classes, which ought to be very efficient on the China and Pacific stations, for instance, and at other points where a war-ship is likely to be needed. These vessels promise to be very handy and

efficient boats, while their cruises can be conducted at a moderate expense. It is not intended to depreciate the value of the larger cruisers and battle-ships which are necessary to a complete navy; but the smaller vessels should not be neglected.

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THE Central and some other lines in the Argentine Republic, which are under foreign control, have met the monetary crisis in that country by raising rates so as to keep them on substantially a gold basis. The result has been a very heavy loss in traffic. Part of this is probably due to the general commercial disturbance, but much of it to the increased rates, which the traffic is not able to bear. Great complaints are made by shippers, and the condition of affairs is shown by the fact that considerable shipments are being made to the ports on the Rio de la Plata by bullock carts, reviving the old method of transportation which the railroads had replaced. The complaint is general that the English boards of directors cannot or will not understand the local conditions, and that the course they are taking is injurious both to the railroads and to the country generally.

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## THE CARE AND CLASSIFICATION OF NOTES, MEMORANDA AND PAPERS.

IN the very interesting "Journal of Sir Walter Scott,"* which has recently been published, the distinguished author says:

> I cannot conceive what possesses me over every person besides to mislay papers. I received a letter Saturday at *e'en*, enclosing a bill for £750. Well, I read it, and note the contents; and this day, as if it had been a wind-bill in the literal sense of the words, I search everywhere, and lose three hours of my morning—turn over all my confusion in the writing-desk—break open one or two letters lest I should have enclosed the sweet and quickly convertible document in them—send for a joiner, and disorganize my scretoire lest it should have fallen aside by mistake. I find it at last—the place where is of little consequence; but the trick must be mended.

In another place, when he was writing the "History of Napoleon," he says:

> It makes me tremble to think of the mass of letters I have to look through in order to select all those which affect the life of *Napoleon*, and which, in spite of numerous excellent resolutions, I have never separated from the common file from which they are now to be selected. Confound them! but they *are* confounded already. Indolence is a delightful indulgence, but at what a rate we purchase it.

It is a curious fact that most of us feel flattered when we discover the same defects of conduct and character in distinguished people that we have ourselves, and it may perhaps be consoling to some of our readers to know that Sir Walter Scott had the same weakness which they have suffered from so often.

We are not all as systematic as we should be; and we are reminded of this oftenest, perhaps, by the apparent sudden disappearance of a paper of some kind which, for the time being, seems to be possessed of a spirit of exasperation. Artemus Ward's expression of "the cussedness of inanimate things" seems to describe some active principle which at times takes possession of papers, notes and memoranda. A retrospective view of such occasions, it is true, generally results in a sort of penitential sense of carelessness, which Sir Walter confessed and resolved—as we all have—to mend.

Nearly everybody keeps a memorandum book of some kind which is, perhaps, all that is needed for those who make few notes or have retentive memories. But there are occupations in which a great many memoranda must or should be made. Sometimes these must be stored away for future use when the recollection of them has been dimmed and their location is forgotten. Besides making and preserving memoranda, few of us, in these days of much printing, escape the obligation or the desire of preserving "scraps." The daily papers, technical journals, books, pamphlets, advertisements, are showered upon us, and we find much material which it is desirable to preserve or index in some way so that it will be within easy reach when needed. The memorandum books of busy people increase in size and number, so that the notes which were made a week, a month, a year, or five years ago cannot be found without a long search and the waste of much valuable time. Most people at some time or other begin keeping a scrap-book. The beginning usually ends in a dismal failure. The work of pasting scraps in a book, and then of indexing them so that they can be found, is so great that few persons persist in it. There is the difficulty, too, of preserving scraps which are printed on both sides of the paper, and also the fact that much of what is preserved in time becomes obsolete or useless. For busy men scrap-books are impracticable unless they have adequate assistance at command. As a consequence of the necessity of making and preserving memoranda and scraps of various kinds, and of the difficulty of doing it satisfactorily, most persons struggle along with the aid of a few books, pigeon-holes, and profanity as best they can, and at times, like Sir Walter Scott, they anathematize their papers and their own careless habits. To all who, by necessity or inclination, collect much miscellaneous material of the kind referred to, what is called the "card catalogue system," for want of a better name, is a great boon and of inestimable service both in the saving of labor in filing such material and in referring to it thereafter. Some years ago a description of this system, which was published in another journal, attracted a good deal of attention, and seemed to interest many readers; and as subjects for editorials which can be written or read in midsummer should not be too abstruse, an explanation of this system will be given again for the benefit of those who have not seen or have forgotten the first one.

The system probably originated or was derived from that employed for catalogues of libraries. Every one who has ever had any experience with either manuscript or printed catalogues in book form knows how imperfect and confusing they become as soon as any very material additions are made to the library. The titles to the new books must then either be interlined or interleaved, and as soon as any considerable number are added, confusion in the classification follows. For this reason the catalogues of many public libraries are now kept on cards. Each title is entered on a card about the size of an ordinary postal-card, and these are then arranged in alphabetical order in suitable receptacles in drawers. When a new book arrives its title is at once written on a card and it is placed in its proper alphabetic position, so that the catalogue is always complete, and the order of classification is not disturbed by entering new titles. It may be essential, and generally is, to index books in several different ways. Thus if we had the MANUAL of Marine Engineering, by A. E. Seaton, its title might be written on the card as follows:

* The "Journal of Sir Walter Scott," from the original manuscript at Abbotsford. Harper & Brothers, New York, 2 vols.

MANUAL of Marine Engineering, by A. E. Seaton.

and it would then be filed just as a word in a dictionary is arranged, in the department devoted to the letter *M*, and in the order of *MAN*. Or it might be written :

MARINE Engineering, Manual of, by A. E. Seaton, or

ENGINEERING, Manual of Marine, by A. E. Seaton, and placed after *MAR* or *ENG*. As we often look for books by their author's name, it would probably also be entered with the author's name first, thus :

SEATON, A. E. Manual of Marine Engineering.

It will thus be seen that the first or the index word entered on the card will be our guide in finding the book, and therefore in using the system both for catalogues and for preserving memoranda, etc., the facility of finding what is thus filed will depend very much on the selection of the index word or words. As has been shown, in making catalogues of books it is often important that they be entered under more than one index word. The same thing is true of the filing of memoranda, etc.

The system for the latter purpose will probably be most readily understood by describing its use in its simplest form. In fact, there is not very much to explain after the description of the method of keeping library catalogues, as its application to the preservation of memoranda, etc., consists simply of selecting an index word for the memorandum, and then writing the word on a card first and the memorandum after it. While many persons who use the system use cards on which they write what is noted, it will be found that an ordinary envelope is equally convenient for this purpose, and has the additional advantage that scraps cut from papers, etc., can be placed inside of the envelope with an index title on the outside and then filed in their proper place.

To begin this system of preserving and classifying memoranda, etc., all that the beginner need do is to buy a box of a "half thousand" envelopes—what are known to the trade as Number 6½ "government" is a good size. These are 6 × 3⅝ in. Any other size will answer, however.

Now suppose it is learned that the weight of a locomotive is 80,000 lbs., and it is desirable to preserve a memorandum of it, all that need be done is to write on one of the envelopes an index word—which in this case would obviously be "Locomotive"—with the weight after it, as follows :

LOCOMOTIVE. Weight of No. 2 on Pa. R. R., 80,000 lbs.

As it might be expected that this item of information would be indexed under the word "weight," the latter might also be written on another envelope, with a reference to the first one as follows :

*Weight.* See Locomotive.

Or suppose a description of the Nicaragua Canal should be found in a paper, and for some reason it would be desirable to preserve the article, it could be cut out, folded, and deposited in one of the envelopes, and the index title NICARAGUA Canal written on the outside.

Or, to continue the examples, supposing that in reading the following maxim is encountered, "*Stubborn clients build fine houses for lawyers.*" It might be filed under the general title "Maxims," or under "Clients," "Lawyers," or "Stubborn Clients," or all four titles might be used. If the definition, "*A bore is a person who talks to you about himself when you want to talk to him about yourself*," should seem worth preserving, it would be indexed under the word BORE, with the definition either written after the index title or deposited on the inside of the envelope. If the address of one of the Smith family was to be recorded, the entry on the envelope would be SMITH, John, 175,299 Peanut Street, Philadelphia.

Another excellent use which may be made of this system is the indexing of notable articles in periodical literature. Thus *The Engineer* recently had a description of one of the American "whaleback barges" which made a voyage across the Atlantic. The record of this would obviously be—WHALEBACK barges. See *The Engineer*, Aug. 7, 1891, page 111, and BARGES. See Whaleback Barges. We all read articles to which it may be desirable to refer in the future, but which can then only be found with an expenditure of time and trouble which we cannot spare. A simple entry on an envelope with a suitable index word, with the title of the article, the name, date and page of the publication in which it appeared, will make it accessible at any time.

The uses of this system are almost infinite. It can be used for preserving and classifying any kind of data, from domestic receipts to mathematical formulæ. An envelope with a record of books loaned will often secure the return of volumes all trace of which would otherwise be lost.

There are also many incidental advantages connected with the system. It always happens that much of the material which we collect becomes useless and obsolete. When this occurs, all that need be done is to destroy the envelope and its contents on which the obsolete material is recorded, or in which it is deposited. The continuity and completeness of the system is not disturbed thereby.

Another convenience grows out of the fact that all the material relating to any one subject is brought together, and when it is needed can be carried away without disturbing anything else.

As soon as the envelopes have titles written on them they can be placed in one end of the box and arranged alphabetically, the blank envelopes being kept in the other end. As the memoranda increase it will be found convenient to place colored cards, about one-quarter of an inch wider than the envelopes, between them. Each card should have one of the letters of the alphabet on its upper left-hand corner. This will facilitate the alphabetic classifica-

tion. When the number of envelopes to be taken care of increases still more, cards of another color should be used, with three letters of the alphabet like the index letters at the tops of the pages of a dictionary.

The system has the great advantage of elasticity, and can be adapted to all sorts of uses. A few envelopes can be carried in a pocket-book, and memoranda can be made anywhere and at any time, and then classified when convenient.

A little use will soon show the beginner that the paper box in which his envelopes were packed is too frail to stand much wear, and he will find that one or more drawers divided into spaces of the width and depth of the envelope box will be required if he continues and enlarges the use of this system.

It will be found, too, that ordinary envelopes will not be large enough to contain all the material relating to certain subjects which will be collected. For such subjects what are known as document or box envelopes may be used. These can be made of any size, but those measuring 4 × 9½ × ½ in. are a convenient size.

Still other subjects will require more room, and drawers or pigeon-holes must then be resorted to, especially if pamphlets are to be added to the collection. A little ingenuity will adapt the system to any occupation, study or profession. The chief difficulty will be found in the selection of index words. A word selected to-day may not be the one which would indicate to us the same subject six months hence. Consequently liberal cross-references are required.

This system can be used for the simplest purposes, and can be adapted for any complicated or extended uses. No better plan can be found for keeping a record of domestic receipts; and students, engineers, authors, and especially editors will find it admirably adapted for preserving all kinds of material.

## TRAFFIC AND SHIPPING ON THE GREAT LAKES.

OUR attention has been called to the fact that the conclusions and comments made in the article under this title, which was published in the June number of the JOURNAL, and which were based on the figures given in Census Bulletin No. 29, are to some extent incorrect, as the figures given in that Bulletin are imperfect. It seems that in the tables given in Bulletin No. 29 all tonnage was omitted that, in the judgment of the Bureau, was "unimportant," but there is no indication as to where and how the dividing line was drawn.

In making up its report on the ship canal between Lake Erie and the Ohio River, the Pennsylvania Canal Commission collected very carefully statistics of Lake shipping. These statistics have been carefully revised and are used effectively in a letter written by Mr. John M. Goodwin, a very active member of the Commission, to the Pittsburgh *Dispatch*, in criticising the Census statement.

As showing the importance of the difference, we give below, side by side the figures of the two statements as to the total floating equipment on the northwestern lakes:

| | Bulletin No. 29. | Canal Commission. |
|---|---|---|
| Side-wheel steamers | 39 | 61 |
| All other steamers | 1,026 | 1,374 |
| Sailing vessels | 882 | 1,247 |
| Total | 1,947 | 2,682 |
| Total difference | | 735 |

The Canal Commission statement seems worthy of credit, and is also confirmed by a later Census Bulletin, No. 66—issued after the article in question was written—which gives a total enumeration of 1,432 steamers and 1,259 sailing-vessels.

In a matter of such importance it is well to have correct figures; and although many of the comparisons made and conclusions drawn will not be materially changed, some of the averages given as to tonnage, etc., will not stand.

Mr. Goodwin's letter, above referred to, is an interesting one, and only lack of space prevents us from publishing it in full. Though written mainly in the interest of the canal, it contains some figures and statements of general interest.

The principal changes which are required in the figures are an increase in the proportion of freight carried by sailing vessels, and a decrease in the average tonnage of steamers.

One conclusion drawn by Mr. Goodwin seems to be supported by the strongest arguments. It is that the maintenance of 20 ft. channels and corresponding water in lake harbors is not reasonably practicable. The true policy for lake shipbuilders and owners is to build ships to suit the waters they must sail in, and not to waste great sums in futile efforts to keep open channels of great depth in persistent opposition to the forces of nature.

As noted in the July number, one vessel—the *E. C. Pope*—recently delivered in Cleveland 2,741 tons of ore on 14 ft. 1 in. draft; and the same ship can carry over 3,000 tons on 16 ft. draft. With ships so designed and built it would seem that the necessity for 20 ft. channels, difficult to secure and impossible to maintain, hardly existed. The Lake shipowners ought to be well satisfied with the performance of their vessels. If financial results are unsatisfactory it is usually in years of comparatively light business, when rates are reduced below the paying point by reckless competition; and for this they have only themselves to blame.

## NEW RAILROAD CONSTRUCTION.

THE amount of new railroad built is always regarded as a kind of barometer showing the general condition of the railroads. To some extent this is true, but it is more expressive of general financial conditions than of the special state of the railroads. At any rate, it is of considerable importance to know what is being done in this direction, and the work of collecting statistics has been undertaken by several of our contemporaries, with results that vary to a somewhat surprising extent. According to the figures collected by the *Railway Age*, which seem to be the most precise and reliable, the total length of new track laid in the six months ending with June—the first half of 1891—was 1,728 miles on 139 different lines. This is a greater mileage than might have been expected, as financial conditions have not been favorable to the building of new lines this year, and very little in the way of extension has been done by the older companies. The indications seem to be that the total new mileage for the year will be over 4,000 miles, and may reach 5,000.

The new building has been pretty well distributed, and has been mainly in short lines or sections. Very little has been done in the West or Northwest, the South continuing to lead, as it did last year. The new mileage in the Southern States was 713, or about 40 per cent. of the total.

Six States added over 100 miles each to their railroads. In Georgia 174 miles are reported; in Pennsylvania, 139; In Washington, 135; in Alabama, 120; in South Carolina, 107; and in Virginia 105 miles. In New York only 2½ miles were built.

The situation at present is that the new building is almost entirely of local lines in settled districts, and that the building of competing and paral'el lines is entirely at a standstill.

## CAR-WHEEL GUARANTEES.

At the annual meeting of the Master Car Builders' Association held last year, a Committee was authorized to consider the report of the meeting of the Association of Manufacturers of Chilled Car Wheels, held November 21, 1889, in New York City. At this meeting the manufacturers adopted the following resolutions:

That when wheels are taken out of service on account of *sharp flanges, flat spots, comby* or *shelled-out treads*, or for *cracked brackets* or *plates*, and it is found on breaking up the wheels that the depth and character of the chill and the strength and character of the metal in the plates are up to the standard specifications adopted by the Joint Conference Committee of the American Railway Master Mechanics', the Master Car Builders' and the Wheel-Makers' Associations, it shall be considered that the failure is due to the service and not to the quality of the wheel, and that the wheel-maker ought not to be called upon in such cases to pay for or replace any such wheels.

To this proviso of the Wheel Manufacturers, the Committee of the Car Builders' Association object, on the ground, first, that it is indefinite, and, second, that its provisions would virtually put the wheel-makers in a position in which they could refuse to replace any wheels; and the Committee then give their reasons for their objections. On another page we publish a communication from Mr. Griffin, the well-known wheel manufacturer of Buffalo, in which he has put in some arguments in rebuttal of the position taken by the Committee.

It is one of those cases in which each count should be considered separately. First, then, should a wheel-maker be required to replace a wheel which fails on account of a sharp flange?

The causes assigned for sharp flanges are: 1, varying sizes of wheels on the same axle; 2, trucks out of square; 3, unequal wear of wheel. With reference to the first cause, the Committee say that "in our opinion" mismating of wheels is now a rare occurrence. Mr. Griffin, on the other hand, says it is a very common one, and that many car-builders will not take the trouble to mate wheels. With reference to the second cause, the Committee say that "our observation would imply that it is not active in producing worn flanges, because if it was it would produce worn flanges on both pairs of wheels." Is this true? If the axles in a truck are not parallel, one of them might be square and the other not, and then one of the wheels on the axle which is not square would probably get a sharp flange, whereas those on the square axle might not be worn. There are also other defects in construction which might cause sharp flanges, such as the center-plates being out of center on the truck or car-body, the draw-bars out of the center line of trucks. It is easy to imagine, too, defects in the suspension links, which would cause the truck to bear more against one flange than against the other.

The Committee say, "in our opinion the difference in the wearing qualities of the two wheels on the same axle is the cause of nearly all flange wear." The fact, though, that the average mileage of wheels which fail on account of sharp flanges is high, is very strong presumptive evidence against this "opinion." If wheels got sharp flanges on account of their poor wearing qualities, their average mileage would not be high, because they would wear out in the tread before making a high mileage, as all poor wheels do. The fact that a wheel makes a high mileage before its flange wears sharp indicates that it has good wearing qualities, and therefore that it is not the lack of such qualities that has caused the flange to wear sharp. If poor wearing qualities were the chief cause of sharp flanges, then the average mileage of such wheels would be low, whereas a study of any wheel report will show that while the average mileage of wheels with worn flanges is not as high as the best wheels, it is nevertheless very good.

For these reasons, if we were called upon to act in the capacity of a judge in this matter, we would decide that if the mileage of a wheel with a sharp flange has exceeded 20,000 miles that the maker ought not to replace it.

As to flat spots, the Committee say, and it is agreed, that there is no question about the responsibility for flat spots produced by sliding, when the cause is apparent; but there are flat spots which are due to defects in the wheel. This is also true of "comby" or "shelled-out treads." These defects, in the opinion of wheel-makers and car-builders, are sometimes a *consequence* of sliding the wheels, but they are also at times due to faults in the castings. The charge of indefiniteness which the Car Builders' Committee make to this provision of the wheel-makers is, it is thought, sustained. The difficulty will probably be to determine whether the defects named are due to misuse or to faults in the metal or the casting of the wheels. A more careful diagnosis of these disorders, with more explicit and definite statement of their symptoms, will probably be the only way by which the responsibility for them may be determined. Concerning "flat spots," the Committee say that "if a proper depth of white iron existed, the wheel would not wear flat;" but the wheel-makers will probably retort they nevertheless do wear flat when there is a proper depth of white iron, and therefore conversely, when there is the proper depth of white iron the wheel-makers ought not be held responsible, which is all they ask.

Regarding comby or shelled-out treads, the Committee and Mr. Griffin seem to hold diametrically opposite opinions, and we know of other wheel-makers and some car-builders who agree with him. The Committee hold that these defects "are entirely due to the quality of the wheels, and are not caused under any circumstances by improper treatment of the railroads," whereas Mr. Griffin holds that "they can be caused by brake-service." A commission of wheel doctors should consider and report on these disorders.

Regarding cracked brackets the responsibility is not so clear. Undoubtedly they are at times, as the Committee say, the result of brittleness in the iron or improper design in the pattern, but it is also true that they are often a consequence of overheating by long application of the brakes. Ordinarily it would not be easy to determine which is the cause. We are inclined to believe that the wheel-makers will be obliged to assume the risk of this defect, because few railroad officers would be willing to assume the responsibility of using wheels which are liable to crack under any kind of usage.

## NEW PUBLICATIONS.

THE MICHIGAN ENGINEERS' ANNUAL. *Containing the Proceedings of the Michigan Engineering Society for* 1891. (F. Hodgman, Secretary, Climax, Mich.)

This number of the *Proceedings* contains several excellent papers presented before the Society by members. Among these may be included one by Mr. Hodgman on the Ownership of Lake Beds; one by Mr. Muenscher on Easement Curves; one by Mr. Teed on Engineering for Lumbermen, and several others of merit. It is well for engineers to have this and similar volumes, for much of the best work of our engineers is contained in them, and they often present valuable records of experience which may be of service in similar cases elsewhere.

A convenient appendix to the volume is a compendium of recent decisions in land cases, of interest to surveyors. The volume is well printed and remarkably free from typographical errors, which are so apt to creep into technical work.

THE LOGARITHMIC SPIRAL CURVE. By William Cox.

THE POLAR PLANIMETER: A MANUAL. By William Cox.

THE SLIDE RULE. By William Cox. (The Keuffel & Esser Company, New York.)

These are three useful monographs. The first describes the manner of constructing the logarithmic spiral and the various uses to which that curve can be put in an engineer's work, in finding the value of proportions, determining centers of curvature, drawing curves, etc.

The second monograph is a description of the polar planimeter and the various methods of using it. This instrument is almost indispensable to engineers, who so often have to ascertain quickly the areas of irregular surfaces. It is an exceedingly ingenious instrument, and its convenience can only be fully appreciated by those who have used it.

The third is a book of 30 pages, in which are described the various uses of the slide rule—an instrument which is, perhaps, more often talked about than used; at any rate, it is not as frequently used as it ought to be. Especially intended for engineers, it is really convenient for every one who has measurements and calculations to make, and that would include almost the whole community. This little book gives one an idea of the various uses to which it can be put; its explanations are generally clear and brief. The only change to be suggested is that it would have been convenient to have such a manual of pocket size.

THE HISTORY AND DEVELOPMENT OF STEAM LOCOMOTION ON COMMON ROADS. By William Fletcher, M.E. (E. & F. N. Spon, New York and London; 288 pages, 108 illustrations.)

This book presents in one volume, for the first time, we believe, a complete history of the various efforts—both successful and unsuccessful—to apply steam as a motor on common roads. The author claims to have made a complete history, and his claim is good so far as the early history of the subject goes, and so far as English practice is concerned; but it is somewhat defective on what has been done outside of England. The book is well arranged and pretty fully illustrated, but it would have been much improved by a complete index.

It is divided into seven sections: Introduction; the Period of Speculation; the Period of Experiment; the Period of Successful Application; the Modern Period; Design and Construction of Road Locomotives; (English) Traction Engine Law.

Mr. Fletcher has done a service in collecting and arranging the history of this subject in a convenient and accessible form, and for this we can pardon him for making too much use of manufacturers' catalogues and circulars in his chapters on modern practice. The book is worth reading and preservation.

MANUAL OF THE RAILROADS OF THE UNITED STATES. By Henry V. Poor. (H. V. & H. W. Poor, New York.)

It is not an easy matter to criticise the yearly volume of *Poor's Manual*. It is not only the best work of the kind we have, it is the only one, and it is quite indispensable for those who are connected with railroads or interested in railroad securities. Nowhere else can such a mass of information be found, and its long period of existence and high standing have given it almost the authority of an official work. Certain defects it has, some of which are unavoidable, from the way in which its information is collected; but there is no doubt that the publishers spare no pains to keep it up to a high standard and to make it as complete and as correct as possible.

The *Manual* for 1891 contains over 1,400 pages, and gives reports and statements of 835 railroad companies in the United States and Canada; there are also reports of a number of equipment, terminal and other auxiliary companies, and summaries for a large number of street railroad companies. How complete the statistics collected are is shown by the fact that in the Introduction the total railroad mileage in the United States is given at 163,420 miles, while the figures given for operations cover 157,976 miles, while the mileage not covered is chiefly of short and unimportant lines, or of new railroads lately brought into operation.

In the Introduction there is a valuable summary of railroad operations for the year, which gives almost the only general view we have of railroad conditions and progress. Some figures from it will be found on another page.

A TREATISE ON THE CALKINS STEAM-ENGINE INDICATOR. *With Description of Calkins' Improved Graduated Pantograph, Polar Planimeter, Speed Measure, Revolution Counter, Parallel Rule, Indicator Spring, Weighing Device, Mercurial Column.* (New York; E. & F. N. Spon.)

The title of this book describes its general character. It contains a very full description and illustrations of the Calkins Indicator, with directions for its use. In the latter part tables and units of various kinds are given, which are useful in connection with the application of the indicator. Directions are also given for calculating the power of an engine from the diagram, for computing the amount of steam used, the duty of boilers, and general remarks on the several lines of indicator diagrams.

The book is well printed and illustrated, and will be an excellent guide to the application of the indicator.

CAR LUBRICATION. By W. E. Hall, B.S., M.E. (New York; John Wiley & Sons.)

Probably few practical railroad men will read the title of this book without some degree of eager anticipation. It relates to a subject which is a never-ending source of annoyance and expense on railroads, and for that reason they are naturally anxious for any information which would help to lessen the annoyance or reduce the expense. It is to be feared, however, that when they read in the introduction that "the object of the following chapters will be, pure and simple, to reduce the conditions to a relationship the nature of which will assist toward reducing this expenditure, either directly or indirectly, to the lowest attainable figure," they will wonder what it all means. Imagine, too, a busy superintendent who has been troubled with hot-boxes turning to this book to learn of a remedy, and encountering on the sixth page the following formula:

$$L = \int^{+} P\, l\, R \cos.\, \omega\, d\, \omega$$

to determine the pressure upon a given surface of the journal. The whole subject is discussed on scientific stilts, and quite over the heads of the large number of people to whom a book of this kind written in a clear and simple style would be useful. A critic of railroad literature often wonders at the blindness of many authors who write for railroad men. It may safely be

said that there are some thousands of people in this country who would be interested in a good book on the subject of Car Lubrication which they could understand. Presumably the book before us was intended to sell, yet it is written in a style which will be incomprehensible to nine-tenths or more of the people who, if they could understand it, would be most interested in it and would be possible buyers of it. This shows a lack of the business sense, which is the more flagrant because the value of the book would not be diminished but increased, even for the most highly educated understandings, if it was written on a lower plane and in a more simple form. Much of the explanation is harder to understand than the thing explained. The following is the formula given to determine the cost of lubricating one journal:

$$2.617\frac{d}{d'} \cdot C\,c\,J\,T + B\,b + O\,o + A\,a + W\,w = M.$$

The subjects treated of in the different chapters are Theoretical Relations, Coefficient of Friction, Bearing Metals, Methods of Lubrication, Journal-box Construction, Cost of Lubrication, and Heated Journals.

Chapter III contains a brief *résumé* of the experiments of Tower and Woodbury, which is useful; but probably practical men will search in vain through the pages of the book for directions to guide them. It is without any index or even a table of contents, which is an unpardonable fault.

## TRADE CATALOGUES.

*Price-List No.* 8, *July*, 1891, *of the Phosphor-Bronze Smelting Company, Limited.* Philadelphia, No. 512 Arch Street.

Few people not especially familiar with the business appreciate the variety of uses to which phosphor-bronze, as made by this company, is now put. An examination of this price-list shows prices for various sizes and weights of phospher-bronze in sheets and rolls; wire, both coarse and fine; wire specially made for telegraph and telephone lines; wire ropes; wire cord; special ropes for power transmission; special ropes for rigging and for steering apparatus; wire cloth; tacks, nails and boat spikes; rolled and cast pump rods; rolled and cast bolts, nuts and washers; wood screws of all sizes; sash chains; bars and rods; split links; pens, for writing; hammers, chisels, scissors, wedges, wrenches, and other special tools for use in powder mills and magazines; valves, cocks and similar work. These are the ordinary lines, and do not include the great variety of castings made, such as bearings, gear wheels, pumps, screw propellers and others, for which the varieties of this metal are specially adapted.

*Revised Price Lists of the Link Belt Engineering Company.* Philadelphia and New York.

This price list shows a great variety of applications of this company's link belting for various purposes, such as in paper-mills, saw mills, foundries, elevators, and almost all kinds of factories. The company also makes numerous attachments of various kinds for use in connection with its belts. It has recently been enabled also, by improvements in its factory, to make a notable reduction in prices of most of its chains.

*Catalogue of the Ferracute Machine Company, Bridgton, N. J. No.* 6. *Assorted Presses.*

This is received too late for comment, except to say that the company is now getting out a new series, which we hope to notice at length.

*The Pelton Water Wheel and Water Motor: Illustrated Circulars. The Pelton Water Wheel Company, San Francisco.*

*Compartment Water Heaters and Condensers, and Artificial Water Coolers: Illustrated Catalogue. Klein, Schanzlin & Becker. Frankenthal, Rhenish Bavaria, Germany.*

## TECHNICAL SCHOOLS.

An addition to the article on this subject in the last number of the Journal is made necessary by the receipt of additional catalogues and other documents. It may perhaps be well to note here that this article was not intended to be a list of all the technical schools, but simply a notice of those catalogues and prospectuses which had accumulated on the editorial desk.

As many of our readers doubtless know, the Massachusetts Institute of Technology, in Boston, is one of the oldest and largest of the institutions of this class, and is probably the best equipped. Opened in 1865, it has had the benefit of more than 25 years' experience, and it has gradually been built up into what might be called an industrial university, with a large teaching staff and excellent appliances. Its organization and methods have served as models for several later schools.

As shown by the latest catalogue, there are now 12 regular courses in the Institute; these are: 1. Civil and Topographical Engineering. 2. Mechanical Engineering. 3. Mining Engineering and Metallurgy. 4. Architecture. 5. Chemistry. 6. Electrical Engineering. 7. Biology. 8. Physics. 9. General Course. 10. Chemical Engineering. 11. Sanitary Engineering. 12. Geology. With the use of optional studies, these courses can be enlarged and diversified, enabling the student to cover a wider range of instruction than is comprised in a single course.

The latest addition made is the Engineering building, which, to describe it briefly, is a structure 148 × 52 ft. and six stories high. It contains recitation rooms, drawing rooms, the library for the Civil and Mechanical Engineering departments, and four laboratories, one for experimental work on strength and other properties of materials; a laboratory of steam engineering; a hydraulic laboratory, and one where other experiments are made. The building itself is intended as an example of the latest and best methods of building mills and of fire-proof or slow-burning construction.

## BOOKS RECEIVED.

*Quarterly Report of the Chief of the Bureau of Statistics, Treasury Department, Relative to the Imports, Exports, Immigration and Navigation of the United States for the Three Months ending March* 31, 1891. Washington; Government Printing Office.

*The Carolo-Wilhelmina Ducal Technical High-School at Brunswick: Programme for the Study-Year* 1891–92. Brunswick, Germany; issued by the School. We have before referred to this school, which holds a high rank in Germany.

*Experiments in Aerodynamics.* By Professor S. P. Langley. Washington; the Smithsonian Institution. This book comes to hand too late to receive in the present number the attention which its importance deserves.

*Annual Statements of the Railroad and Canal Companies of the State of New Jersey for the Year* 1890. Trenton, N. J.; State Printers.

*Tabellen zur Berechnung der Flächeninhalte, der Terrainbreiten und der Böschungsbreiten, der Querprofile bei Wege und Grabenbauten: by Friedrichsen, Royal Surveyor.* R. Von Decker, Berlin, Germany. This is a very complete set of earthwork tables, accompanied by diagrams and formulas. The explanations, etc., are, of course, in German, and the tables follow the metrical system of measurement.

*Massachusetts Institute of Technology: Annual Catalogue,* 1890–91. Boston; published by the Institute.

*A Technical Description of the Engineering Building of the Massachusetts Institute of Technology.* Boston. This is a reprint from the *Proceedings* of the Society of Arts connected with the Institute.

*Transactions of the Technical Society of the Pacific Coast, January-June*, 1891. San Francisco; published by the Society. This number of the *Transactions* contains several valuable papers.

*Occasional Papers of the Institution of Civil Engineers.* London, England; published for the Institution. The papers included in the present installment are the Counterbalancing of Locomotives, by Edmund L. Hill; the New Nadrai Aqueduct, by William Good; the Sewerage of Dudley, by E. D. Marten; Petroleum Storage Installations, by R. Pickwell; Irrigation in Southern California, by W. Fox; Electric Mining Machinery, by L. B. Atkinson and C. W. Atkinson; Abstract of Papers in Foreign *Transactions*.

## ABOUT BOOKS AND PERIODICALS.

A PAPER on Glass in Science in the POPULAR SCIENCE MONTHLY for September completes the series on Glass Making, by Professor Henderson, and describes the methods of making thermometer tubes, hydrometers, lenses for telescopes, etc. Mr. Garrett P. Serviss submits some arguments on the question of whether we can always count upon the Sun. Other papers are by Professor John Fiske, Dr. Andrew D. White and Herbert Spencer, making a number of solid interest and value.

Among the more important articles in SCRIBNER'S MAGAZINE for September are Mr. Ricalton's account of some of the little-known monuments of antiquity found in Ceylon; Mr. Spears' paper on Odd American Homes, and Professor Royce's on University Life. In the Steamship Series, Lieutenant Hunt furnishes the closing article, which is on the Steamship Lines of the World, including a sketch of the possibilities of travel now open to the voyager with time and means.

A new weekly electrical paper has been started in Chicago. It is called ELECTRICITY, and will present the popular side of electric matters for the general reader rather than the specialist. The first numbers contain some excellent articles well illustrated, and the managers are evidently determined to deserve the success which we hope they will secure. The paper is very attractive in appearance, and is worthy of attention from all who are interested in electricity— and that includes a great many people now.

In the number of HARPER'S WEEKLY for August 5 there is an illustrated account of the Naval Reserve drills at New York. The Boston drills had been described in a previous number. The number for August 19 discusses the Chilian question at considerable length. In that for August 12 Lieutenant-Colonel W. R. King discusses the measures to be taken for the defense of New York against a hostile attack.

The TECHNOLOGY QUARTERLY for August has the Commencement address of the President of the Massachusetts Institute of Technology. Mr. C. Frank Allen writes of a Course of Instruction in Railroad Management, and there are several articles of special technical interest.

Very few American readers are able to take the foreign magazines, but many would like to follow the general current of foreign thought and writing. For such readers there can be nothing better than the old-established ECLECTIC MAGAZINE. The range it presents is well shown by the August number, which contains articles from 16 different English periodicals, nearly all the leading ones, the choice including a variety of more serious articles and of lighter reading.

A new monthly paper called the COMPASS has been started by the Keuffel & Esser Company, New York, under the editorship of Mr. William Cox. It is proposed to make this a useful companion for the engineer, treating each month of new instruments for field and office work; principles of the construction of instruments; descriptions of new works, and other items. The first number has 16 pages, about the size of *Harper's Magazine*, and contains some excellent reading; it promises well for the future, and the new venture should be a successful one.

In the August number of GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE there are articles on the Inter-Continental Railroad; China's First Successful Railroad; Controlling the Mississippi; Our Physical Geography; the Northern Limit of Mankind, and others on a variety of topics. This magazine aims at condensation, and its articles are generally short, bright and readable; many of them really conveying a great amount of information in a small space.

In HARPER'S MAGAZINE for September, Montgomery Schuyler's Glimpses of Western Architecture are continued, this second paper treating of the domestic architecture of Chicago. There is another chapter of the history of London, and an excellent historical article on the New York Chamber of Commerce. This issue is notable for the number and variety of the illustrations.

The paper of most interest to railroad men in the ARENA for August is "Should the Nation Own the Railroads?" by C. Wood Davis. There are several others which every one who thinks and who believes in the progress of the human race should read. This magazine is above all one for thoughtful people, and never fails to have articles which will at least interest, even if they do not convince such readers.

The man—or woman—who is in search of outdoor recreation for a summer or fall vacation cannot do better than to read OUTING for August. Its contents are varied, and almost every article is of interest to the general reader, whether he takes to any special form of sport or not. This magazine has improved very much of late in the quality of its illustrations, and has also increased their number.

In the OVERLAND MONTHLY for August will be found an exceedingly interesting article on Gold Mining of To-day. Some comments on the Relief Map of the Pacific Region, with an engraving of the map, give a better comprehensive idea of the topography of the Pacific Coast than anything we have ever seen. This magazine is valuable to any reader who wants to know what is going on upon the Pacific Coast, and this gives it a special interest apart from its general literary excellence.

## NOTES.

THE previous record for fast trips across the Atlantic was broken in August by the *Majestic* and the *Teutonic*, both of the White Star Line. The fastest previous voyage had been made by the *City of Paris*, of the Inman Line. The *Majestic's* trip was made in 5 days, 18 hours, 8 minutes; the *Teutonic's* in 5 days, 16 hours, 31 minutes. In both cases the weather was favorable. The two trips and that of the *City of Paris* may be compared in the following table, which shows the daily runs:

| *Knots run on* | *Teutonic.* | *Majestic.* | *City of Paris.* |
|---|---|---|---|
| First day | 460 | 470 | 432 |
| Second day | 496 | 501 | 493 |
| Third day | 505 | 497 | 502 |
| Fourth day | 510 | 501 | 506 |
| Fifth day | 517 | 491 | 509 |
| Sixth day | 290 | 317 | 346 |
| Total | 2,778 | 2,777 | 2,788 |

On the *Teutonic's* trip the average speed was 20.35 knots an hour, with 80 revolutions of the screws and 180 lbs. boiler pressure. The consumption of coal was about 300 tons a day.

SOME experiments in electric lighting have recently been made by the Safety Electric Light Company, of Boston, whose system has been put on a parlor car of the New York & New England Railroad. The company uses a primary battery, and the trials are said to have been very successful so far.

## THE INTER-CONTINENTAL RAILROAD.

(From *Goldthwaite's Geographical Magazine.*)

THE International American Conference, which was held in Washington over a year ago, appointed an Inter-Continental Railroad Commission to take in charge the preliminary steps toward the great project of connecting North and South America by a railroad. The Commission has been in session in Washington this year, and before its adjournment until February next, it appointed three surveying parties to go to various portions of the proposed route, make the preliminary surveys, and decide upon the practicability of the undertaking. Word has been received that these parties have reached their destinations, and it is expected that they will return to this country with their reports in a little over a year.

The first report of the Commission has been submitted to the Secretary of State. It outlines the proposed route of the great railroad. A line of railroad, it says, is projected, and has been surveyed from the City of Mexico to Ayutla, on the frontier of Guatemala. From Ayutla the proposed line runs parallel with and not far from the Pacific coast through Mazatenango to Santa Lucia, thence by Cuajiniquilapa to Santa Anna in Salvador. Then the line turns rather abruptly east away from the Pacific, through Nuevo San Salvador and San Miguel to Goascoran in Honduras. From Goascoran the line will skirt the head of the Gulf of Fonseca, through the State of Choluteca to the city of the same name; thence the line passes through Chinadega in Nicaragua to Rivas on Lake Nicaragua, and along the west shore of the lake through Alajuela in Costa Rica, and on through San Jose to Puerto Limon, on the Carribbean Sea. This is the only place where it touches Atlantic waters.

Thence it passes down the Isthmus of Panama to the valley of the Atrato, where the isthmus joins South America. In Colombia the line will cross the western cordillera of the Andes into the valley of the River Cauca, and up this valley to Popayan. A branch road will be run from the main line east to the city of Bogota. From Popayan, the line will cross the mountains a little west of south to Pasco near Ecuador, and will thence continue through by the cities of Tulcan, Ibarra, Quito, Cuenca and Loja and into Peru, running through Ecuador, west of the main cordilleras. Through Peru, the route, as laid down on the map, will pass through the provinces of Cajamarca and Amazonas, and across formidable mountain ranges to the River Maranon, the head waters of the Amazon, and through its valley to Cerro de Pasco; thence the route will pass along the River Perene and on to Santa Anna, thence to Cuzco, Santa Rosa Puno, on the west side of Lake Titicaca, where the railroad will connect with the Pacific line, terminating in the port of Mollendo. Then the road will continue down the west side of Titicaca to the Bolivian frontier, and, on its way south, will pass through the cities of La Paz and Oruro to Huanchaca. Here the main line terminates at 20° S. latitude, and west southwest of Potosi. From Huanchaca trains will reach Chili, the Argentine Republic, Paraguay and Uruguay by branch lines. Venezuela will be connected with the trunk line by a branch from some suitable point in the valley of the Cauca to Medellin, where it will connect with an existing railroad to the city of Puerto Berrio, on the Magdalena River, and continue through Bucaramanga, San Jose de Cucuta, and Merida to Valencia.

We probably shall not hear very much more of this project until the reports of the parties that are making the preliminary surveys are received. Not a few men who are more or less familiar with most of the regions to be traversed are exceedingly sanguine that favorable reports as to the practicability of the railroad will be made. It is certain that among the cordilleras of Colombia and Ecuador enormous difficulties must be overcome, and the railroad will be a most extensive enterprise, whose cost will perhaps not be justified by the commercial results for many years to come. There can be no doubt, however, of the ultimate carrying out of this project, and it is a wise and far-seeing policy to take hold of the great project now with a view to ascertain the financial burden it will involve, the engineering difficulties to be met, and the best means of making it a reality.


PENETRATION OF A SHOT FROM THE ARMSTRONG 110-TON GUN.

## WHAT THE 110-TON GUN CAN DO.

THE accompanying illustration and description are taken from an account of the exhibit made by Sir W. G. Armstrong, Mitchell & Company in the Naval Exposition in London, given in *Engineering*. Referring to the 110-ton gun, it says:

The full charge of this weapon is 960 lbs. of brown prismatic powder, which costs $400; and the steel projectile weighs 1,800 lbs. and costs $425. This makes a total of $885 (including small items, such as fuses, etc.) for each round with full charge and armor-piercing shot. The life of a 110-ton gun is put down at 75 rounds with full charges, while that of the 67-ton gun is 120 rounds. The wear and tear occasioned by the full, three-quarters and half-charges may, we are told, be considered to be in the proportion of three, five and ten; thus the 67-ton gun could fire 400 half-charges or 290 three-quarter charges, while the 110-ton gun could fire 250 half-charges or 125 three-quarter charges. It is obvious that full charges are to be sparingly dealt in with these costly weapons, and it is equally obvious that there is no need to do otherwise than deal sparingly with them in peace operations, and perhaps, too, oftener in war operations than one is generally apt to imagine.

It will be remembered that the 110-ton gun firing a 1,800-lb. projectile with 960 lbs. of powder had a muzzle velocity of 2,105 ft. per second, the total energy being 55,305 foot-tons. The figures are sufficiently impressive to those sufficiently accustomed to such matters to grasp them, but the Elswick authorities have rightly concluded that it would bring the matter much more closely home to the ordinary exhibition visitor were there put forward a graphic delineation of what the 110-ton gun can do. They have, however, had made full-sized and very realistic drawing of the course through a target of the projectile fired from the *Sanpariel's* 110-ton gun on March 14 last. The illustration given is taken from a photograph of this graphic delineation of the power of the monster gun. The shot met first of all a 20-in. compound armor plate. At the

back of this was an iron backing plate 8 in. thick which was fastened to a heavy wrought-iron frame. Beyond was built up a structure consisting of solid oak balks. These occupied a thickness of 20 ft. Next came 5 ft. of granite, and beyond that was 11 ft. of concrete. Finally there was 5 ft. of brickwork. The shot struck fairly in the center of the plate, traveling at a velocity of 2,079 ft. per second. It went through both plates, then in turn through the 20 ft. of oak, the 5 ft. of granite, and the 11 ft. of concrete, and was finally brought up by the bricks at the end, although it forced out a large wedge of brickwork, and almost got through.

## CAR-WHEEL GUARANTEES.

By P. H. Griffin, President New York Car-Wheel Works.

Referring to the Report of the Committee on Wheel Guarantee as submitted to the Master Car Builders' Convention, in June, 1891, at Cape May, N. J., I have to state some facts on the subject that have been developed by a very careful study of the cause of flange wear in particular, and the causes of wheel failure in general.

The causes of flange wear as apparent to me are given in the order of prominence :

1. Variation in diameter.
2. Variation in gauge.

When it is considered that a variation of $\frac{1}{16}$ in. in diameter between two 33-in. wheels on an axle would cause the larger one to travel *ten feet* farther in one mile if it could, and that the greater the load the more certainty of quick destruction from such a condition, there is little mystery about the main reason for flange wear or why it has increased of late years with the higher speeds and greater loads.

The M. C. B. rules accept wheels pressed on axles with a variation of ¼ in. from gauge.

It is the rule in many shops to press both wheels on an axle at the same time, and to work the wheel-press at a very rapid rate to save time. This causes imperfect conditions that must produce extra friction, undue wear, and poor service. The second cause may help to counteract the first in one case, and in the opposite will double the rapidity of failure on account of flange wear.

The Committee state that, in their opinion, mismating at the present day is a rare occurrence. On what premises is that opinion based ? As a result of inspection of wheels fitted to axles or not ? Of course any railroad man would promptly say that his wheels were properly mated ; but how many can show a careful inspection of wheels before fitting them to axles to see that uniform diameters go in pairs ? How many railroad shops have any appliances for making such a test ? How many builders of freight cars give the matter a thought ? Some car-wheel makers tape and stencil all wheels for diameter ; but it is not required that they do so as a rule, and when done there is not much attention given by the wheel fitters to the verification of the marking as being correct. We gauge our wheels by sixty-fourths of an inch diameter, and find considerable trouble in getting users of them to put like numbers on same axles ; they say it is too much bother. It is not difficult to prove the facts, however. At any railroad shop or along the line will be found many pairs of wheels fitted to axles ready for service. Any one interested can test them and see what the average result is. It may be found far from the condition indicated by the report of the committee.

The conditions of the present day are referred to as an improvement on those of the past ; but what change has been made in the average practice in fitting up chilled wheels except, perhaps, to turn out a greater number daily with the same plant ? The work used to be done years ago by mechanics, the quantity required was smaller, and the time spent upon it was greater ; two cuts were taken out of the wheel to insure accuracy. Now the work is done in many car and repair shops by laborers more or less skilled ; whether the wheel hubs are hard to bore or not, the daily "stint" must be kept up, and the result cannot be toward a higher standard.

The Committee give as their opinion that "the difference in the wearing quality of two wheels on one axle is the cause for nearly all flange wear, and for this wear the wheel-makers should be held responsible."

If the Committee is correct in their finding, why is not the proposition of the wheel-makers a fair one ?—viz. : that "Wheels failing for sharp flange should be broken, and if the depth and character of chill are up to the standard specifications adopted by the Master Mechanics' and Master Car Builders' Associations, then the wheel-maker ought not to replace the wheel."

It is very easy to determine whether a wheel is properly chilled or not. A piece can be broken out of the flange with a small sledge and without handling the wheel at all. The M. C. B. Specifications were taken almost literally from the Pennsylvania Specifications, and the intent of both is to insure that wheels of proper chill and strength be furnished. If they are so furnished, is it fair to stipulate that wheel-makers be responsible for failures due to causes beyond their control ?

It must be remembered that the Pennsylvania Specifications do not require the wheel-maker to give a guarantee ; the wheels are rigidly examined before being accepted, as being of proper strength and chill, and as to being perfect in other details. Once accepted on these conditions, that is the end of it. The M. C. B. Specifications, however, propose to add a most exacting guarantee to the Pennsylvania Specifications to make the wheel-maker comply with all the conditions that should exist in a good wheel, which is all right, and then to make him assume responsibility for the results of conditions of service over which he has no control ; that is all wrong.

The Committee state that as to "flat spots" they understand the term to mean wheels having spots on them which have worn through the chill, and "that at this spot an inspection would show that a proper depth of white iron did not exist." Well, if it did exist, what then ? Presumably the wheel could not be classed as a failure. The Committee go on to state that "shelled out" treads are entirely due to the quality of the wheel, and are not caused under any circumstances by improper treatment of the railroads.

The knowledge and experience of many railroad men will bear me out in the statement that "flat spots" and "shelled out" spots can be caused on all well-chilled wheels by brake service ; and it is simply a question with a well-chilled wheel whether it is removed soon enough after brake sliding has occurred to prevent shelling out, or whether it has been run for long enough time to cause the iron (burned by friction at the flat spot) to shell out under pressure of load carried of from three to six tons with a corresponding blow on the wheel 300 to 600 times in every mile traveled.

The finding of the Committee on cracked brackets and plates is correct in the main, as good wheels will undoubtedly give better results in this particular than poor ones ; but their statement that "with good wheels it is safe to say that for every wheel that fails in this way twenty pass the ordeal successfully and fail from finally wearing out." What about that one good wheel ? Was it a failure for which the wheel-maker should be responsible ?

Sufficient consideration has not been given this wheel question in respect to the radical changes in the speed and load of trains that have been made in the last ten or fifteen years. Every advance in that direction imposed greater duties on the wheels. Brake service of to-day does not much resemble that of ten years ago. Freight cars are being equipped with air brakes, and passenger and freight trains weighing from 500 to 1,000 tons are run at speeds varying from 30 to 60 miles per hour on the presumption that they can be promptly stopped when necessary. The wheels must furnish the means of doing that through the medium of the brakes. Is it fair to ask wheel-makers to be responsible for the results of such vital changes as these ? When the engineer has the power to apply instantly a force of 25 tons air-brake pressure per car on wheels loaded with a weight of three to five tons each and revolving at from 300 to 600 times per minute, what must

be the result? No metal will stand such treatment without damage; yet the Committee say that defects arising from such a service "are entirely due to the quality of the wheel, and are not caused under *any circumstances* (the italics are mine) by improper treatment of the railroads."

It is a well-known fact that cracked plates are caused entirely by brake service, mainly on high grades. Many railroads without excessive grades have no trouble of this kind, and other roads with high grades remove thousands of wheels annually for this cause. It occurs more frequently in freight service, and is caused by the fact that brakes must be set on the cars on heavy down grades to prevent loss of control over the train. Brakemen have orders to set them moderately on a number of cars, but to save time and trouble, set them excessively tight on a few cars—often merely set the brakes on the caboose and one or two cars adjoining, and allow the train to run down a long grade in this manner. The wheels are bound to heat up, and where brakes are tightly set on long grades, it is almost impossible to prevent plates cracking from expansion. In fact, any wheel can be cracked in the plates in this way if the application is continuous and severe enough. Is it fair to return wheels ruined in this way to the wheel-maker, and refuse an investigation as to whether they were of proper quality? If the railroads must save the loss arising from such a condition, they should do it through attention to the brakes. If the latter were lightly set on a greater number of cars, or if the application was changed from one car to another, so as to prevent excessive heating, the damage would not be done.

Railroad managers buy steel wheels at from six to eight times the net cost of chilled wheels, and without question assume the expenses for wear attributable to brake service. They buy costly lathes; and if steel wheels are slid flat or run to sharp flange they are removed and the tire turned down without a thought of the maker being responsible. The total mileage obtained from steel wheels is always referred to as if it were obtained without constant labor and expense in refitting and returning the tires to obtain it.

No one believes that the M. C. B. Association or any other body of railroad men intend to impose unfair conditions on any one, or that even if they did so from a misapprehension that they would continue to enforce them.

The subject of chilled wheels is one that is not understood as it should be, and there is no one cause as distinctly responsible for the lack of knowledge as the guarantee. It would appear, on the face of the matter, that railroads would be benefited by a practice that enabled them to buy supplies without investigation of quality or character —to do business, as it were, under "bond and mortgage." Had there never been a guarantee, had railroads bought car wheels as they do other material, more attention would have been paid to the subject, and better information would have been gained as to what a chilled wheel is, what it should do, and what it cannot do; then there would have been more progress in fitting it for the increased demands of to-day.

This has not been the case, however. In the main, orders have been placed with the lowest bidder because he would give *a guarantee*; that such a manufacturer can change his business arrangements as often as he chooses, and is in no way really bound to his promises, does not seem to affect the case. The responsible manufacturer must meet the same conditions or lose business. What is the result? The majority of railroads in this country are putting wheels under their cars to-day that do not net the makers *one and one-half cents per pound*. These figures include all scrap values for old wheels returned, and represent the total net price received by the maker for his wheels. Well, it may be possible that wheel-makers are alchemists and can furnish proper wheels at such prices, but it is not likely. Why should this be the case? It is not fair to say that wheel-makers are responsible for this condition as a body because a certain number among them have helped to create it. It is all very well to say that they should not sell wheels unless they can get a price that admits of furnishing good ones; but when their very best customers—the leading railroads of the country—tell them they must meet competition or lose the business, what is to be done? It is doubtful if a body of men can be found who have worked harder, have really done more in any one thing to enable the wonderful economy of American railroad practice than the practical car-wheel makers of this country. As a rule, they are men who commenced at the bottom and worked up; so have the majority of the men with whom these practical questions must be settled. It cannot be that either body wants anything unfair of the other. Certainly the wheel-makers have reached a point where they cannot go farther. It is useless to impose more exacting conditions on them than they now labor under. To tell them that no allowance has been or will be made for the increase in service their wheels must give, consequent on the double speed and double load of to-day as against that of 10 or 15 years ago, cannot be the intention of any committee or association.

The proper solution of this question is to leave it in such shape that investigations will be made. No other course will determine the good and the bad.

The drop test proposed as a part of the wheel specifications can be used precisely as well on wheels worn out as on new wheels; and it is surely not too much to ask, and no fair-minded railroad man will refuse to investigate alleged failures before saying to the wheel-makers that they must throw away time and money fairly rendered simply on the ruling of the Association and without any investigation of the facts.

Of all the various parts of a car, not one approaches in importance the car wheel. It must do all the work of transmitting energy into motion to move the load and of transferring motion into friction and heat to stop it. It must do this while sustaining the load. It must perform these services with the temperature at 20° to 30° below zero, or at 90° to 100° above. There is hardly a strain, or shock, or blow that can be imagined that a car wheel does not have to stand, and yet these are only the outward and recognized tasks imposed on it. With every movement the small but never-ending shock and blow of service must affect its body. What we know as motion is simply an infinitely multiplied movement, and the greater the motion the greater the movement. If car wheels simply transmitted motion, that would be a different thing, but multiply that service by the load carried, and that product by the energy that is constantly transferred into heat with brake service, and an idea can be gained of what a car wheel must do.

The chilled wheel is expected to pass from the foundry as a rough and unfinished casting and give results that can be obtained from the most costly steel wheels upon which all mechanical art can do has been done regardless of expense.

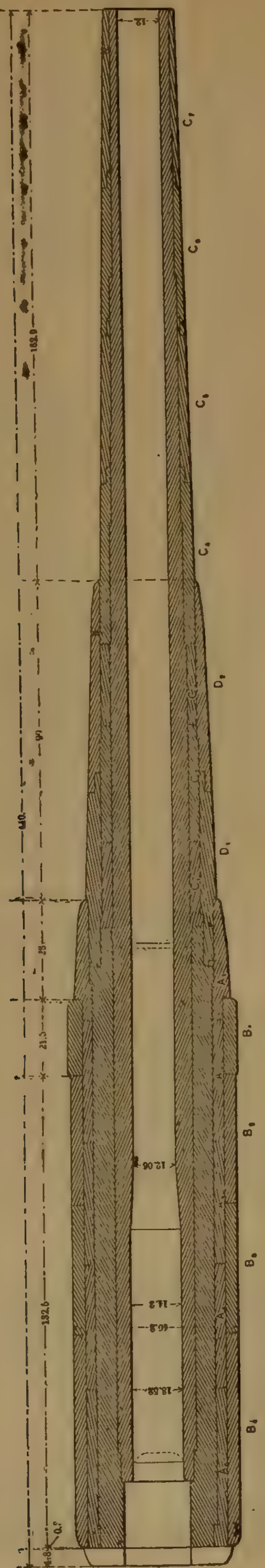
If the makers of chilled wheels can obtain but a small degree of the consideration afforded the makers of steel wheels, the result will amply repay the railroads; and if a proper course is to be pursued and the manufacture of chilled car wheels brought to the standpoint it should occupy, fair consideration must be given to all the influences bearing upon it. It will not do for railroad officials to discharge the subject with the assertion that it is not their affair. When they ask wheel-makers to furnish wheels that will not imperil life and property, they must be willing to treat the subject on a basis that will admit of such a thing being done.

APPENDIX.

The Canada Southern Division of the Michigan Central Railroad is equipped with 119 locomotives. They run on one of the straightest pieces of track in America. In the year 1890 the total number of wheels removed from under their engines as worn out was 728. Of these 416 were removed on account of sharp flange. The average mileage of all wheels removed was:

| | Worn out from | | | |
|---|---|---|---|---|
| 33 in. | Sharp flange, | 65,730. | Other causes, | 58,522. |
| 30 in. | " " | 53,670. | " " | 53,772. |
| 28 in. | " " | 59,030. | " " | 60,430. |

The following individual cases of mileage of wheels ultimately failing from sharp flange indicates that as a final cause of failure flange wear is the question to be met:



THE 12-INCH ARMY BREECH-LOADING RIFLED GUN.

——— Failed account sharp flange. ———

| | | | | |
|---|---|---|---|---|
| Rem'v'd in Jan., 1891, from Engine No | 410, | 2 28-in. Trk. whls. | — | 121,373 m. |
| " " " " " " " | 423, | 2 30-in. Tdr. | " | —123,093 m. |
| " " " " " " " | 378, | 2 30-in. Tdr. | " | —108,434 m. |
| " " Dec., 1890, " " " | 364, | 2 30-in. Tdr. | " | —118,116 m. |
| " " Nov., 1890, " " " | 357, | 2 30-in. Tdr. | " | —100,741 m. |
| " " Oct., 1890, " " " | 419, | 2 33-in. Tdr. | " | —119,937 m. |
| " " " " " " " | 385, | 2 30-in. Tdr. | " | —103,177 m. |
| " " " " " " " | 349, | 2 28-in. Trk. | " | —132,231 m. |
| " " " " " " " | 349, | 2 28-in. Trk. | " | —102,730 m. |

As a remarkable fact, nearly all of the wheels making over 100,000 miles ultimately failed on account of flange wear. This proves that the conditions causing flange wear are not necessarily associated with poor wheels.

## THE ARMY 12-INCH GUN.

THE accompanying illustration, for which we are indebted to the courtesy of the *Iron Age*, shows a longitudinal section of the new 12-in. army breech-loading rifled gun. One of these guns—the first of a number now under construction—is now undergoing its trials at the proving ground at Sandy Hook.

This gun was built at the Watervliet Arsenal, West Troy, N. Y., where a large and well-fitted plant has been established for building guns. A noteworthy fact is that when the construction of this gun was authorized it was not possible to obtain steel forgings of the requisite size in this country, and therefore the tube and jacket were made by Whitworth, the hoops being of home material, and all of the work being done in the Watervliet shops. So rapid has been the growth in the steel works in this country that the material for the guns now under construction, and for those which may be ordered in the future, will all be furnished by home concerns.

The new gun is of the built-up type; it weighs 52 tons, is 12 in. in bore and 440 in. long over all. The outside diameter at the muzzle is 20¼ in., at the trunnions 47.8 in., and at the breech 46.2 in. The exterior diameter of the tube at the muzzle is 17.4 in., and at the breech 22 in.; the jacket being 33.54 in. in diameter and 174 in. long.

This gun and the 13-in. navy rifle are the largest guns of modern type yet undertaken here. Probably these sizes will not be exceeded for service guns, though a 15-in. or 16-in. experimental gun may be built hereafter.

## THE HOLTON BASE.

By PROFESSOR J. HOWARD GORE.

WHEN the Kent Island base-line, near Baltimore, was measured several decades ago, it was not thought probable that its accuracy would receive a test at a point more than 500 miles to the westward; nor, in fact, did any one at that time suppose that a triangulation within this century would extend half so far from the eastern shore. The Kent base served as the foundation of a strong chain of triangles which were projected along the general trend of the coast—far enough back to rest on elevations of requisite heights for suitable length of triangle sides, yet sufficiently near to furnish frequent checks for the triangulation of shorter sides on which the shore topography and off-shore hydrography could rest. To do work of this kind was the original function of the Coast Survey. But when these chains of primary triangulation assumed greater proportions it became apparent that they could be put to use in contributing geodetic data, and as soon as this idea attained its proper hold on the legislative mind the Coast Survey became the Coast and Geodetic Survey. In planning the work for this reorganized institution a transcontinental chain was decided upon, and work was soon begun along the 39th parallel. In course of time several independent parties were put in the field to measure bases at somewhat regular intervals, and to extend the triangulation east and west from each of these until the intervening gaps are filled, and thus the entire chain completed. Those who are familiar with the care and accuracy with which the officers of the Coast and Geodetic Survey do

their work will realize what a huge undertaking this has been, and all who are interested in the exact sciences will fully appreciate its importance.

That portion of this arc known as the eastern section has been from its inception in the hands of Assistant A. T. Mosman. He took as his starting line one of the lines of the Atlantic coast chain which rested on the Kent Island base. None but those familiar with this class of work and the rough character of those portions of Virginia, West Virginia, Ohio, Kentucky, and Indiana, through which this portion of the arc passes, can form a just conception of the enormity and variety of difficulties which confronted Mr. Mosman in the prosecution of his labor. The reconnoissance has been exceedingly difficult, especially in those localities where hills of nearly the same height abound, or in lower lands which are heavily timbered. The next segment of this arc, in charge of Assistant G. A. Fairfield, has its base near the Missouri River, and in the 250 miles of its eastward course passes over a low country where hills of sufficient height are wholly lacking, and signals to be seen must be from 100 to 150 ft. high. These two sections of arc meet on a common line in Southern Indiana, and being an element in two independent chains, this line has two values. If the county surveyor is anxious until he finds that his latitudes and departures balance, what must be the feeling of suspense as the computations for the lengths of a junction-line approach completion—especially when the bases are nearly 1,000 miles apart, with an intervening chain representing almost a score of years!

As could be expected, when the reputation of the two chiefs is considered, the rough computation for the lengths of this line in common gives results which are in wonderful accord. But in order to properly distribute the slight discrepancy, it was deemed advisable to measure a new base near the junction. This is the Holton base, situated near Holton, Ripley County, Indiana. Numerous bases have been measured in various parts of this country, and the bibliography of the subject covers many pages; but it is safe to predict that in varieties of methods, ingenuity of devices, and elaboration of results, none will equal Holton base. The mere determination of the length of the base within the usual limits of accuracy would be quite a simple operation, but its favorable location suggested that some of the theoretical features connected with base-line work might here be subjected to practical tests, so that the Holton base not only enters as a factor in the transcontinental chain, but it takes, as an experimental base, a most important place in the history of Geodesy.

First of all comes the measurement with a modified form of the secondary apparatus, in which a single bar of steel forms the measuring element. The changes in the way of improvements are in the direction of securing more accurate temperature determinations, and more reliable data for making corrections for inclination. This measurement is under the immediate supervision of Assistant O. H. Tittmann, whose Colorado base forms a part of this arc. Two measurements with this apparatus will give all that is demanded even by the exacting conditions of a geodetic arc. But in order to apply a crucial test to the claims of those who insist that tape-line measurements can be made with all needful exactness and in less time, extensive preparations have been undertaken for measuring this base with tapes of steel and of bronze, singly and conjointly, supported and unsupported, and of different lengths. The details have received most careful attention, and so far give evidence of a complete mastery. Tension along the tapes is under control, and the dreaded question of temperature no longer appears formidable.

In all linear determinations the uncertainty as to the length of the unit employed while in actual use has caused the greatest concern. This is particularly the case when long tapes are used. But in the present case that uncertainty becomes a vanishing quantity. Very near the base a 100-meter comparator has been constructed, on which it is possible, through an intermediary five-meter bar compared with the metric prototype, to lay off points whose distance apart is any distance desired. These transfers are made under conditions exactly similar—the go-between in both cases being surrounded by ice. From a number of measurements, lengths of 25, 50 and 100 meters are laid off on this comparator, then the tapes are applied, and from oft-repeated observations at various temperatures their exact lengths are ascertained. Then, too, all the data essential for the determination of coefficients of expansion are in hand, together with the requisite information regarding the effect of coiling and uncoiling on the length of the tape. From this it can be seen that the tapes are most carefully compared with a reliable standard and under conditions similar to those which will prevail during the actual measurement of the base. These tapes will be used repeatedly in ascertaining the length of the entire base, and the results will doubtless go far toward settling the question as to what shall be used hereafter in measuring bases.

In order to institute still further comparisons, and to test the absolute accuracy of the various methods of measuring, one kilometer of the base will be measured with the same bar, in ice, which was compared with the prototype. This bar is a line measure, and must, therefore, be passed successively under microscopes, two and two; and to secure reliable results, great stability of microscopes is absolutely necessary. To secure this, the inventive genius of Assistant R. S. Woodward, who is in charge of this special investigation, has found ample play. During a sojourn of three months on the ground, daily using various parts of the apparatus, and comparing them with other forms which I have employed before, I have found much that was unique and original, and still more that gives promise of yielding results far in advance of anything of its kind ever attempted before.

The entire work is under the direction of Mr. Mosman, whose name, to the gratification of his friends, will always be associated with the Holton Base—a work which will soon be known throughout the world.

## THE ENGINES FOR THE NEW BATTLE-SHIPS.

THE accompanying drawings show the engines designed by the Bureau of Steam Engineering, Navy Department, for the new battle-ships now under construction. These ships have been heretofore described, but for convenience of reference their main dimensions are here repeated: Length, 348 ft.; breadth, 69 ft.; mean draft, 24 ft.; displacement, 10,000 tons. They have a heavy water-line belt of armor, and will carry a very heavy armament. The engines are described as follows in the report of Engineer-in-Chief George W. Melville:

These ships are designed for a cruising speed of 15 knots and are to be propelled by machinery capable of developing, when forced 9,000 H.P., and under ordinary conditions, 8,000 H.P., driving twin screws.

The main engines are inverted, vertical, direct-acting triple-expansion, with cylinders of 34½ in., 48 in., and 75 in. in diameter, and 42 in. stroke, and it is estimated that at a piston speed of 900 ft. per minute or 129 revolutions, the I.H.P. will be 9,000.

Each engine and its auxiliaries will be separated from the other by a fore-and-aft water-tight bulkhead, so that in case of accident to one engine the other would not be affected.

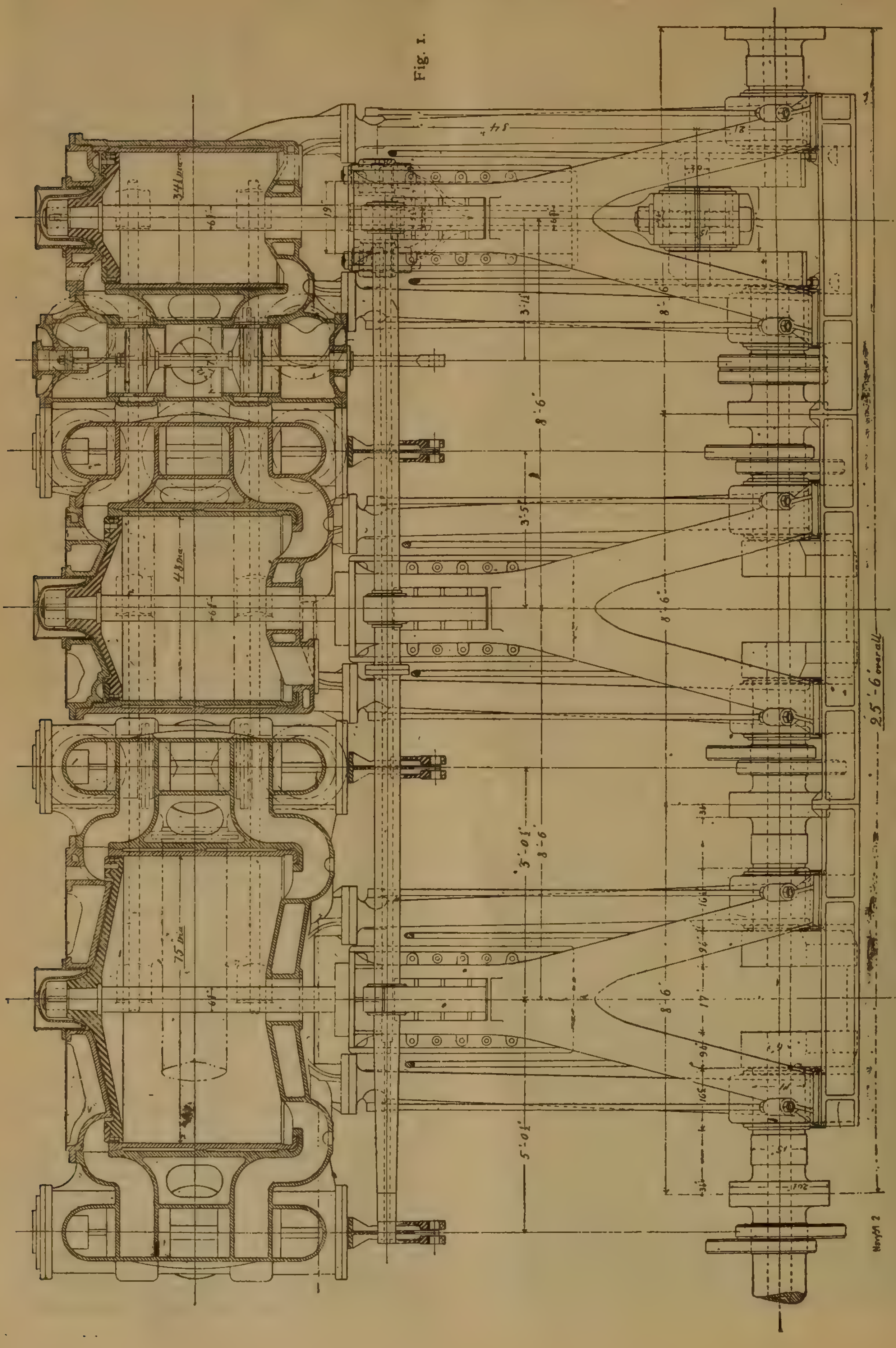
The main valves will be of the piston type, worked by Stephenson double-bar links; one valve for each high-pressure cylinder, two for each intermediate, and four for each low-pressure cylinder, the diameter of all the valves being 17 in.

The intermediate and low-pressure cylinders are steam jacketed at sides and bottom; the high-pressure ones have linings, but are not jacketed. The framing consists of an inverted Y-column at the back of each cylinder and two forged steel cylindrical columns at the front. The engine bed-plates will be of cast steel supported on wrought-steel keelson plates which are built in the ship.

The piston-rods, valve stems, and all working rods are to be of mild forged steel; the pistons will be of cast steel.

The crank-shafts will be of mild forged steel; they will be made in three sections which will be reversible and

Fig. 1.

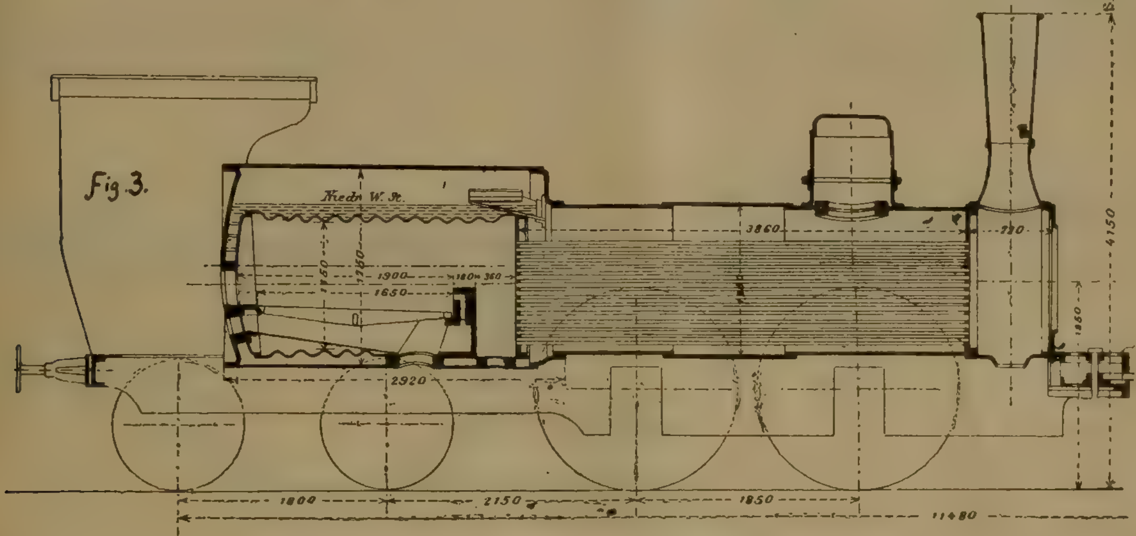



ENGINES FOR COAST LINE BATTLE-SHIPS NOS. 1, 2 AND 3, U. S. NAVY.

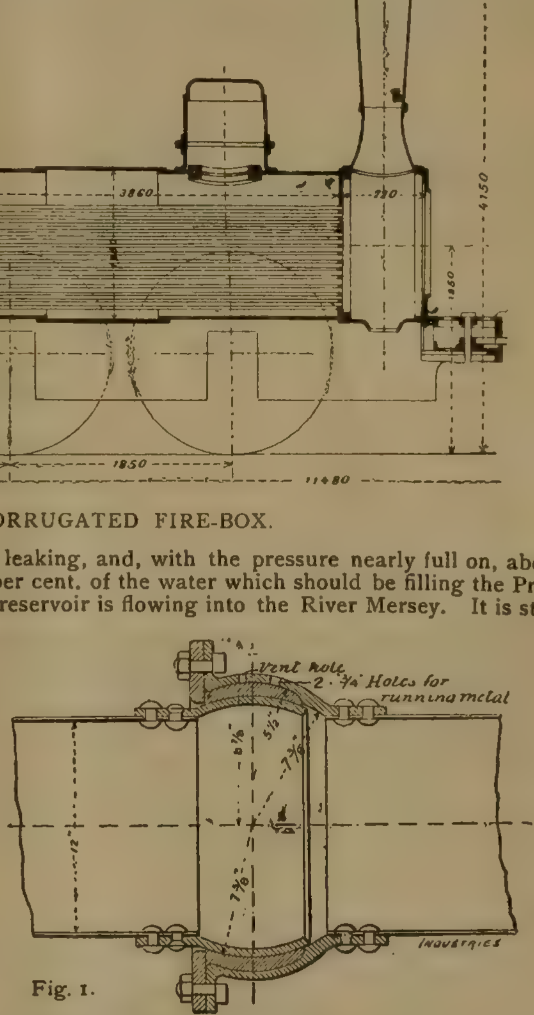
DESIGNED BY THE BUREAU OF STEAM ENGINEERING. GEORGE W. MELVILLE, CHIEF OF BUREAU.

the River Vyrnwy, the waters of which are now impounded by the masonry dam, forming a lake 4¾ miles long, with an acreage of 1,121 acres when full, and a maximum depth of 84 ft. Compensation water to the river below has to be provided for at the rate of 10,000,000 galls. per day, and 40,000,000 galls. upon four days in each of the months between March and October inclusive. The size of the masonry dam is as follows: Width of base, outside toes, 117.75 ft.; height from base to top of overflow, 128 ft.; maximum depth from top of dam to bottom of lake, 84 ft.; area of typical section, 8,972 sq. ft.; weight per lineal foot, 645 tons; its specific gravity, 2.57; maximum pressure on inner toe, 8.7 tons per sq. ft.; on outer toe, 2.26 tons per sq. ft. The total length of dam is 1,173 ft. The aqueduct commences at the straining tower in the middle of the lake, a culvert 2,295 ft. long passing under the bed of the lake; it then enters the Hirnant tunnel, 2.375 miles long. The pipes, 42½ in. in diameter, then pass underground for about 7 miles, except when crossing a stream, and then discharge the water into the Parc Uchaf balancing reservoir. They then pass another 6 miles underground, and enter the Cynyerion tunnel, 0.875 mile in length, and passing the narrow Morda Valley, enter the Llanforda tunnel, a mile in length, and discharge into the Oswestry reservoir, having a capacity of 46,112,000 galls. The water passes through the filter beds to the clear water reservoir, whence it flows for 17 miles underground to Malpas—except when crossing the Wych Brook, with nine arches—into the balancing reservoir. The pipes then proceed for another 11 miles underground to the Cotebrook balancing reservoir, and thence to Norton, 11 miles away. The hill being below the hydraulic gradient a tower has been built in place of a balancing reservoir. In this last length the pipes pass under the River Weaver and two main railroad lines. The next length, from Norton Tower to Prescot, is 9.25 miles long, and has to pass under the Manchester Ship Canal and the River Mersey.

This crossing under the Mersey has been a source of trouble both to the engineer and the contractor, on account of the treacherous nature of the sub-strata, and has been the cause of litigation between the contractor and the Corporation, the case being now heard before Sir John Coode as arbitrator. On account of the great delay in the construction of the tunnel which was to contain the mains, it was decided to put a temporary pipe line across the bed of the river, the necessary leave having been obtained from the Board of Trade. The pipe consists of fifty lengths of 12-in. steel tubes, making a total length of 800 ft. The joints of the pipes are flexible, and are constructed as shown in fig. 1. In addition to the flexible joints, Mr. Deacon, the Corporation engineer, devised some special valves, which were attached to the under side of the pipes, with the intention that, as the pipes were being laid across the bed of the river, the force of the water in the mains would force open the valves and scour a bed for the pipes, the valves then to close automatically. The pipes were laid across the river about six weeks ago in a very clever manner. The pipe line of 800 ft. was laid zigzag in a trench, a block of wood being under each joint, and riding on the ways; along each side of the pipes was a wire rope secured to the extreme end of the pipes, and passing over to the Cheshire side of the river, where they were attached to a steam winch. Eight boats were moored at intervals across the river to guide the pipes as they were being drawn across; a number of horses were also attached, and, with the united forces of the steam winch and the horses, the pipes were successfully pulled across the river in 27½ minutes. Unfortunately, the valves under the pipes have become deranged with the dragging across the banks, and will not close; some of the flexible joints are leaking, and, with the pressure nearly full on, about 75 per cent. of the water which should be filling the Prescot reservoir is flowing into the River Mersey. It is stated, however, that the leaks were expected, and will close up in time, and meanwhile divers are at work upon them to hasten the desired result.




LOCOMOTIVE BOILER WITH CORRUGATED FIRE-BOX.



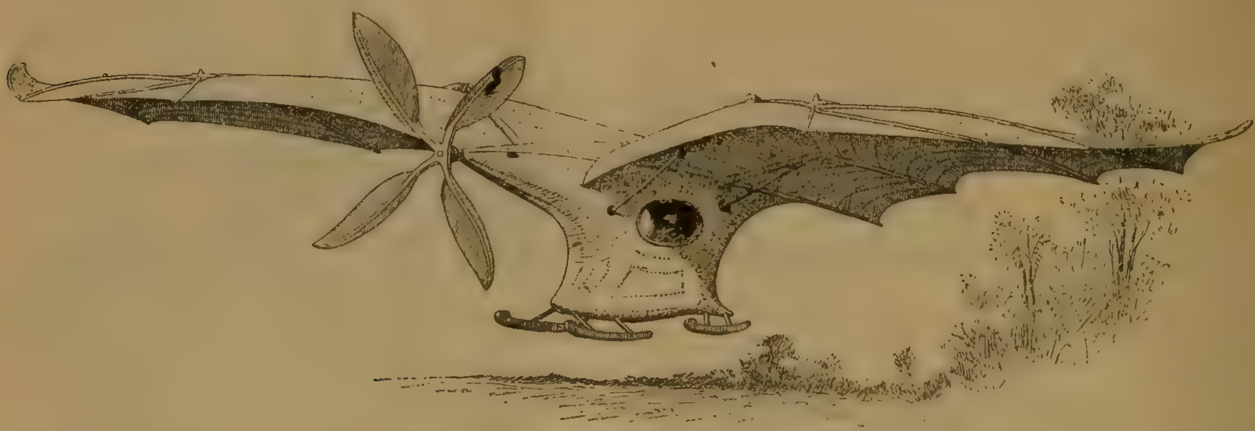

## A NEW FLYING MACHINE.

THE accompanying sketch, which is taken from *l'Illustration*, of Paris, shows a flying machine which has been built recently by M. Ader, the famous French electrician and inventor. Some time ago M. Ader became convinced that the true secret of successful aerial navigation lay in imitating the flight of the larger birds, such as the vulture and the eagle. With this in view he took all possible op-

portunities of studying the motions of such birds, even going so far as to spend several weeks at Constantine and Sidi-M' Sid, in Algeria, where large vultures abound.

The result of his observations is embodied in the machine which is shown in the sketch. The wings are of silk stretched over a light framework, are as nearly as possible of the same form as those of a large vulture, and have an extreme spread of 54 ft. The car or carriage, which takes the place of the body of the bird, carries the motor and the man who is to direct the movements of the machine. It has in front a large screw which is relied on to direct the machine and propel it through the air. The wings have a flapping motion, to be used when rising; this and the revolution of the screw are produced by the motor carried in the car.

It is impossible to give a better description, as M. Ader will not make public the details until his experiments are concluded. The motive power is understood to be electricity, but what motor is used and whether storage batteries or other appliances are carried is known only to M. Ader and his assistants. It is known, however, that with this machine he has risen to a height of 50 or 60 ft., and has made flights of 1,000 and 1,200 ft. in horizontal distance so successfully as to encourage him to continue experiments.



THE ADER FLYING MACHINE.

In this matter M. Ader agrees with some other investigators in believing that success in aerial navigation, if it comes at all, will not come from the development of the balloon, but from the flying machine. The balloon can be relied on for lifting power only, and all attempts to direct its flight have been so far without the success which is needed to make it available.

## EXPERIMENTAL RESEARCHES ON MECHANICAL FLIGHT.

(Translated from a communication by Professor S. P. Langley, of the Smithsonian Institution, to the Paris Académie des Sciences.)

I HAVE been carrying out some researches intimately connected with the subject of mechanical flight, the results of which appear to me to be worthy of attention. They will be published shortly in detail in a memoir. Meanwhile I wish to state the principal conclusions reached.

In this memoir I do not pretend to develop an art of mechanical flight; but I demonstrate that, with motors having the same weights as those actually constructed, we possess at present the necessary force for sustaining, with very rapid motion, heavy bodies in the air; for example, inclined planes more than a thousand times denser than the medium in which they move.

Further, from the point of view of these experiments, and also of the theory underlying them, it appears to be demonstrated that if, in an aërial movement, we have a plane of determined dimensions and weight, inclined at such angles and moving with such velocities that it is always exactly sustained in horizontal flight, the more the velocity is augmented the greater is the force necessary to diminish the sustaining power. It follows that there will be increasing economy of force for each augmentation of velocity up to a certain limit, which the experiments have not yet determined. This assertion, which I make here with the brevity necessary in this *résumé*, calls for a more ample demonstration, and receives it in the memoir that I have mentioned.

The experiments which I have made during the last four years have been executed with an apparatus having revolving arms, about 20 meters in diameter, put in movement by a 10-H.P. steam-engine. They are chiefly as follows:

1. To compare the movements of planes or systems of planes, the weights, surface, form, and variable arrangements, the whole being always in a horizontal position, but disposed in such a manner that it could fall freely.

2. To determine the work necessary to move such planes or systems of planes, when they are inclined, and possess velocities sufficient for them to be sustained by the reaction of the air in all the conditions of free horizontal flight.

3. To examine the motions of aërostats provided with their own motors, and various other analogous questions that I shall not mention here.

As a specific example of the first category of experiments which have been carried out, let us take a horizontal plane, loaded (by its own weight) with 464 grams, having a length of 0.914 meter, a width of 0.102 meter, a thickness of 2 mm., and a density about 1900 times greater than that of the surrounding air, acted on in the direction of its length by a horizontal force, but able to fall freely.

The first line below gives the horizontal velocities in meters per second; the second the time that the body took to fall in air from a constant height of 1.22 meters, the time of fall in a vacuum being 0 50 second.

| | | | | | |
|---|---|---|---|---|---|
| Horizontal velocities ... ... | 0m., | 5m., | 10m., | 15m., | 20m. |
| Time taken to fall from a constant height of 1.22 meters ... ... ... ... | 0.53s., | 0.61s., | 0.75s.. | 1.05s., | 2.00s. |

When the experiment is made under the best conditions it is striking, because, the plane having no inclination, there is no vertical component of apparent pressure to prolong the time of fall; and yet, although the specific gravity is in this more than 1,900 times that of the air, and although the body is quite free to fall, it descends very slowly, as if its weight were diminished a great number of times. What is more, the increase in the time of fall is even greater than the acceleration of the lateral movement.

The same plane, under the same conditions, except that it was moved in the direction of its length, gave analogous but much more marked results; and some observations of the same kind have been made in numerous experiments with other planes, and under more varied conditions.

From that which precedes, the general conclusion may be deduced that the time of fall of a given body in air,

whatever may be its weight, may be indefinitely prolonged by lateral motion, and this result indicates the account that ought to be taken of the inertia of air, in aërial locomotion, a property which, if it has not been neglected in this case, has certainly not received up to the present the attention that is due to it. By this (and also in consequence of that which follows) we have established the necessity of examining more attentively the practical possibility of an art very admissible in theory—that of causing heavy and conveniently disposed bodies to slide or, if I may say so, to travel in air.

In order to indicate by another specific example the nature of the data obtained in the second category of my experiments, I will cite the results found with the same plane, but carrying a weight of 500 grams—that is, 5,380 grams per square meter, inclined at different angles, and moving in the direction of its length. It is entirely free to rise under the pressure of the air, as in the first example it was free to fall; but when it has left its support, the velocity is regulated in such a manner that it will always be subjected to a horizontal motion.

The first column of the following table gives the angle $a$ with the horizon; the second the corresponding velocity $V$ of *planement*—that is, the velocity which is exactly sufficient to sustain the plane in horizontal movement, when the reaction of the air causes it to rise from its support; the third column indicates in grams the resistances to the movement forward for the corresponding velocities—a resistance that is shown by a dynamometer. These three columns only contain the data of the same experiment. The fourth column shows the product of the values indicated in the second and third—that is to say, the work $T$, in kilogram-meters per second, which has overcome the resistance. Finally, the fifth column $P$ designates the weight in kilograms of a system of such planes that a 1-H.P. engine ought to cause to advance horizontally with the velocity $V$ and at the angle of inclination $a$.

| | $V$ | $R$ | $T=\frac{VR}{1000}$ | $P=\frac{500 \times 4554}{T \times 60 \times 1000}$ |
|---|---|---|---|---|
| 45 | 11.2 | 500 | 5.6 | 6.8 |
| 30 | 10.6 | 275 | 2.9 | 13.0 |
| 15 | 11.2 | 128 | 1.4 | 26.5 |
| 10 | 12.4 | 88 | 1.1 | 34.8 |
| 5 | 15.2 | 45 | 0.7 | 55.5 |
| 2 | 20.0 | 20 | 0.4 | 95.0 |

As to the values given in the last column, it is necessary to add that my experiments demonstrate that, in rapid flight, one may suppose such planes to have very small interstices, without diminishing sensibly the power of support of any of them.

It is also necessary to remark that the considerable weights given here to the planes have only the object of facilitating the quantitative experiments. I have found that surfaces approximately plane, and weighing ten times less, are sufficiently strong to be employed in flight, such as has been actually obtained, so that in the last case more than 85 kilograms are disposable for motors and other accessories. As a matter of fact, complete motors weighing less than 5 kilograms per H.P. have recently been constructed.

Although I have made use of planes for my quantitative experiments, I do not regard this form of surface as that which gives the best results. I think, therefore, that the weights I have given in the last column may be considered as less than those that could be transported with the corresponding velocities, if in free flight one is able to guide the movement in such a manner as to assure horizontal locomotion—an essential condition to the economical employment of the power at our disposal.

The execution of these conditions, as of those that impose the practical necessity of ascending and descending with safety, belongs more to the art of which I have spoken than to my subject.

The points that I have endeavored to demonstrate in the memoir in question are:

1. That the force requisite to sustain inclined planes in horizontal aërial locomotion diminishes, instead of increasing, when the velocity is augmented; and that up to very high velocities—a proposition the complete experimental demonstration of which will be given in my memoir; but I hope that its apparent improbability will be diminished by the examination of the preceding examples.

2. That the work necessary to sustain in high velocity the weights of an apparatus composed of planes and a motor may be produced by motors so light as those that have actually been constructed, provided that care is taken to conveniently direct the apparatus in free flight; with other conclusions of an analogous character.

I hope soon to have the honor of submitting a more complete account of the experiments to the Academy.

## THE ODER-SPREE CANAL.

(Condensed from *Annales des Ponts et Chaussées*.)

REFERENCES have heretofore been made to various works for the improvement of water communication in Germany, and to the attention which is being paid in that country to the inland waterways generally. One of the more important works of this kind is now in progress in the Oder-Spree Canal, concerning which a few preliminary statements may be of interest.

The old Margravate of Brandenburg, the original nucleus from which grew up the kingdom of Prussia, is a wide and generally level plain, lying between the Elbe and the Oder and intersected by the Havel, the Spree and their tributaries; it also contains several small lakes. These rivers are not generally of sufficient size to be navigable. There are already in existence old canals uniting the Oder and the Elbe, but these do not approach Berlin and are not of sufficient size to carry the boats in use on either of the great rivers. The new canal is part of a system which is intended to reach all points of importance in Brandenburg, and to permit the passage of the boats which have been in use on the Elbe since the regulating and deepening of that river was completed.

The Lower Oder, below the confluence of the Neisse, can now carry for the greater part of the year the boats in use on the Elbe. A plan for the canalization of the Upper Oder is now under consideration and will probably be carried out. The object of the Oder-Spree Canal is to furnish a line connecting the Oder and the Elbe, which will also reach the city of Berlin.

The new canal leaves the Oder at Fürstemburg, passes under the Berlin-Breslau Railroad, and then by a series of three locks reaches a level 43.5 ft. above the Oder. This level is 22.6 miles in length, and includes 7.1 miles of the old Frederick-William Canal, which has been enlarged and deepened. This level extends to Lake Kersdorf, from which the channel descends by a single lock into the Spree. That river has been deepened and straightened for a distance of 9.3 miles, to Fürstenwalde, where there is another lock. Below this the channel follows the Spree for 3.7 miles to a sixth lock, where the canal leaves the river and enters a level of entirely new construction, 16.3 miles in length; a supply of water for this level is secured by damming the Spree below the junction lock. This level ends in Lake Wernsdorf, and a descent is made by a seventh and last lock into the Dahme, a tributary of the Spree. The Dahme, with the necessary regulation, serves as the bed of the canal until it reaches the Spree again at Cöpenick, from which point that river has already been made navigable to Berlin.

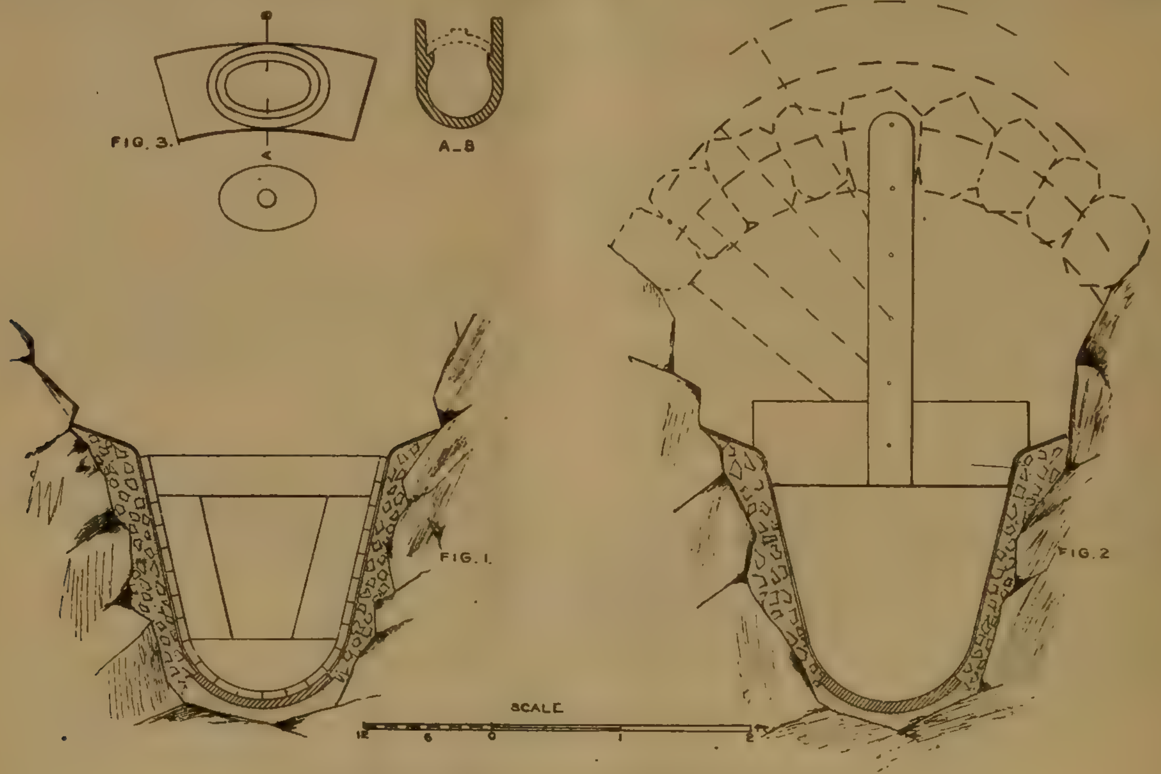
The total fall from the summit level to Cöpenick is 29.4 ft., which is made in four locks. The total number of locks is seven, as already noted; two of these, at Fürstemburg and Wernsdorff, have a fall of 16.2 ft. each, the elevation of the others being less.

The total length of the canal is 54.7 miles, which includes 34.7 miles of entirely new construction, 7.1 miles of the old Frederick-William Canal enlarged, and 12.9 miles of regulated river channels.

The canal is made throughout 45.9 ft. wide at the bottom and 76 ft. at water level, for a depth of 6.56 ft., the great inclination of the banks being adopted on account of the nature of the soil, which is generally a very fine sand. For a considerable part of its length the banks are protected from wash by rip-rapping. While the dimen-

sions given above are the minimum, they are exceeded at several points as required by local circumstances.

The locks have been made to admit of the passage of the average sized boats in use on the Elbe, which are 172.5 ft. long, 23 ft. wide, and draw 5.7 ft. of water when



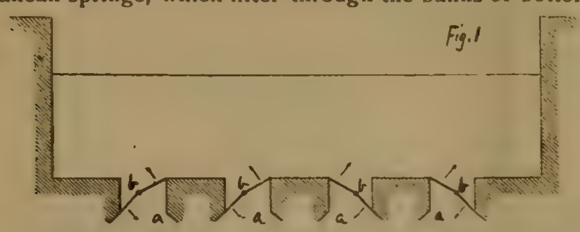

CONCRETE SEWER AT MOUNT VERNON, N. Y.

loaded. The locks are 180 ft. long, 28.2 ft. wide at the gates and 31.5 ft. at the center, and carry 8.2 ft. depth of water. It is proposed, however, to enlarge the canal hereafter to take in the largest class of boats in use on the Elbe. In that case a second lock, 220 ft. long, will be built alongside each of the existing ones, and the minimum section of the canal will be increased to 53.1 ft. width at bottom and 89.2 ft. at water-level, with a depth of water of 8 2 ft.

The bridges over the canal are all built so as to give two clear openings of 32.8 ft. each, and the minimum height is 11.5 ft. above the water-level.

The masonry works include the seven locks; two double-track railroad bridges; a road bridge in the marshes of the Oder; a bridge at Fürstemburg carrying a highway road and a steam tramway; 16 highway bridges, each 14 8 ft. in width; a bridge and automatic guard-gate intended to close the canal in case of a break in the banks; two other guard-gates and a number of culverts and smaller works.

A large part of the water supply will come from subterranean springs, which filter through the banks or bottom.




In addition to this the summit level can be fed from the Schlaube, which carries a considerable volume of water. Should this prove insufficient at any time, it will be necessary to pump up water from the Spree at Neuhaus.

The total amount of excavation required is about 6,530,000 cub. yds. Part of this is done by dredges, but the larger part is excavated dry. Wherever possible steam-shovels are used, and in many places the earth excavated is deposited alongside of the canal, thus saving transportation.

The masonry is generally of brick, set in cement. The locks are founded on béton worked in on a sub-floor of plank set on piles. The gates at the upper ends of all the locks are of iron and are worked by capstans; these will hereafter be replaced by hydraulic apparatus. The lower gates are of wood, and move around horizontal axes. In filling the lock water is introduced from below, as shown in fig. 1, by channels *a a a a* made in the masonry, and closed by valves *b b b b* set in the openings and balanced so that they can be easily opened. The locks are emptied by lateral channels, also made in the masonry and closed by valves.

At latest accounts the canal was very nearly completed. The expectation was that it would be opened by the close of 1890, but some delays have occurred. A large part of the canal is in use, however, and the whole will soon be opened.

## BUILDING A CONCRETE SEWER.

(Paper by Mr. William Worthen, before the American Society of Civil Engineers.)

In laying out the main outlet sewer at Mt. Vernon, N. Y., it was found that a large portion of the line must be excavated through rock, and I decided that for economical reasons the sewer should consist of a concrete channel, constructed *in situ*, with an arch covering in stone. In this way all the rock saved from the trench was valuable for the macadamizing of streets, no earth was necessary for filling over the arch, which would have been needed if cement or vitrified sewer pipe had been laid, and this earth involved long haul. In addition, such a cross-section could be secured that a man could readily pass through the sewer, a convenience in cleaning, and a saving in the number of manholes. It was not supposed that at Mt. Vernon the sewer would be used as a subway for electric wires, gas or water pipes, but it could be readily arranged for such purposes.

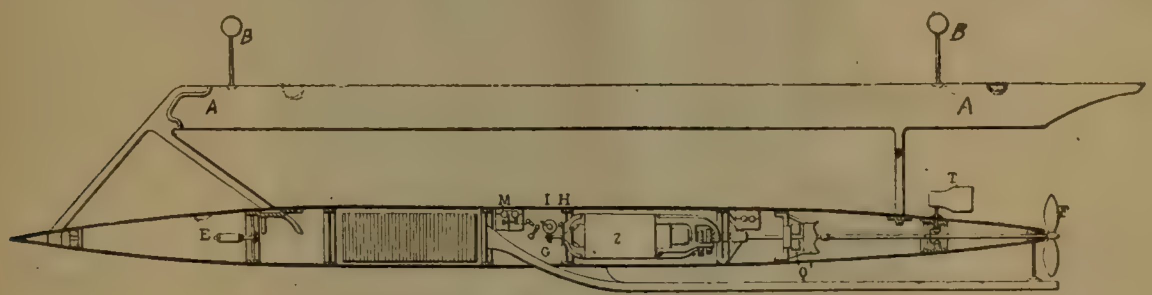
Figs. 1 and 2 show sections of the sewer and the general form of construction; only the minimum of rock excava-

tion was required, sufficient in all cases to give a few inches in thickness of concrete. The invert is a section of vitrified pipe, such as is sold for such purposes ; this is bedded in cement mortar on the rock or on concrete to a true line and grade ; on this is placed the invert center, fig. 1, and concrete of Rosendale cement-mixed 1 cement, 2 sand, and 4 of broken rock not larger than 2 in., is rammed around its sides. After the concrete has set, the invert center is removed and the face of the cement is struck with a thin coat, say ¼ in. thick, of Portland cement well troweled on, a plumb ⊥, fig. 2, of which the base fits the opening of the channel, is placed within it so as to be central and vertical. In this plumb are a number of holes, which are centers for describing the arch, and the centers used are those best suited to the rock excavation. In this case the radius of the arch was invariably 2 ft., and this radius, either by a string or rod, was applied at different centers, till one was found best adapted to the rock cut.

Under this bid the 100 new guns will be furnished by the Bethlehem Company as follows :

| | Time. | Price. | |
|---|---|---|---|
| *8-in. Guns :* | | | |
| Type gun............ | 730 days. | $41,416.50 | |
| 24 service guns... ... | 2,433 " | 413,917.20 | |
| | | | $455,333.70 |
| *10-in. Guns :* | | | |
| Type gun............ | 882 " | $73,755.58 | |
| 49 service guns... ... | 3,407 " | 1,751,631.42 | |
| | | | 1,825,387.00 |
| *12-in. Guns :* | | | |
| Type gun............ | 1,024 " | $106,568.72 | |
| 24 service guns....... | 3,194 " | 1,307,357.28 | |
| | | | 1,413,926.00 |
| Total amount of contract............ ........ | | | $3,694,646.70 |

The delivery of the service guns is to be made at regular intervals after that of the type gun in each case, the time given in the table being that specified for the completion




THE SIMS-EDISON TORPEDO.

In general the arches were laid horizontal and the same center in the plumb used for a convenient length or section ; after that another center might be taken with a vertical offset, but if more convenient, the arches might be laid on an incline, so that in some places the sewer would be 6 ft. to 7 ft. high. The practice was to arrange for the skewbacks first and then set the usual centers of about 3 ft. wide and complete the arch from stone from 10 in. thick and upward, taken from the cut and laid in cement. The upper surface of the arch was kept as high as the rock cut and the proper depth below the grade of the street would admit.

This construction applied only to the main outlet sewer, in which there was no spur for house connections ; all the other sewers were of vitrified pipe of various diameters from 8 to 18 in., the minimum being 8 in. All the house connections were 6 in. in diameter. By the provisions of the contract there was to be a capped ⊥ pipe next to the bend from the spur. The idea was to obtain ready access for the removal of obstacles in either the main sewer or its branches. To simplify this, the bend, fig. 3, was adopted, which was the first connection with the spur on the main line. The oblong hole gives a ready and short reach to both the main line and to the house connections. After the cover is put on with earth packing, the trench is filled in, and access can be got only by digging down. The usual depth of mains is 9 ft. to invert, and the distances between spurs, 25 ft. on each side.

In manholes where the lateral sewer came in on a level considerably above that of the main sewer, I put a ⊢ on the line of the lateral and just inside of the wall of the manhole with the upper end open, so that the flow of the lateral was readily seen, and the other end was extended down with an elbow at the bottom to the level of the main sewer.

## CONTRACTS FOR NEW GUNS.

THE Acting Secretary of War on August 10 approved the recommendation of the Board of Ordnance and Fortification that the contract for 100 high-power, breech-loading, rifled steel guns be given to the Bethlehem Iron Company, Bethlehem, Pa. The award is made under Schedule E, the lowest of five bids submitted by that company ; the difference in prices was considerable, and the difference in time also.

of the last gun. The price per service gun is : 8-in., $17,246.55 each ; 10-in., $35,747.58 each ; 12-in., $54,473.22 each.

The Bethlehem Company has now a very fine plant for making the heavy steel forgings required for these guns, and will doubtless be able to furnish them in excellent shape.

## THE UNITED STATES NAVY.

THE 2,000-ton cruiser now under construction at the Union Iron Works, Baltimore, will be named *North Point.* This ship comes under the same class as the *Concord*, vessels in which are required to receive the names of battles, and the name just given is intended to commemorate the fight at North Point, near Baltimore, in the War of 1812.

The practice-ship is not yet named, but it has been proposed to call her *George Bancroft*, in memory of the eminent historian, who was also the Secretary of the Navy under whose charge the Naval School at Annapolis was established.

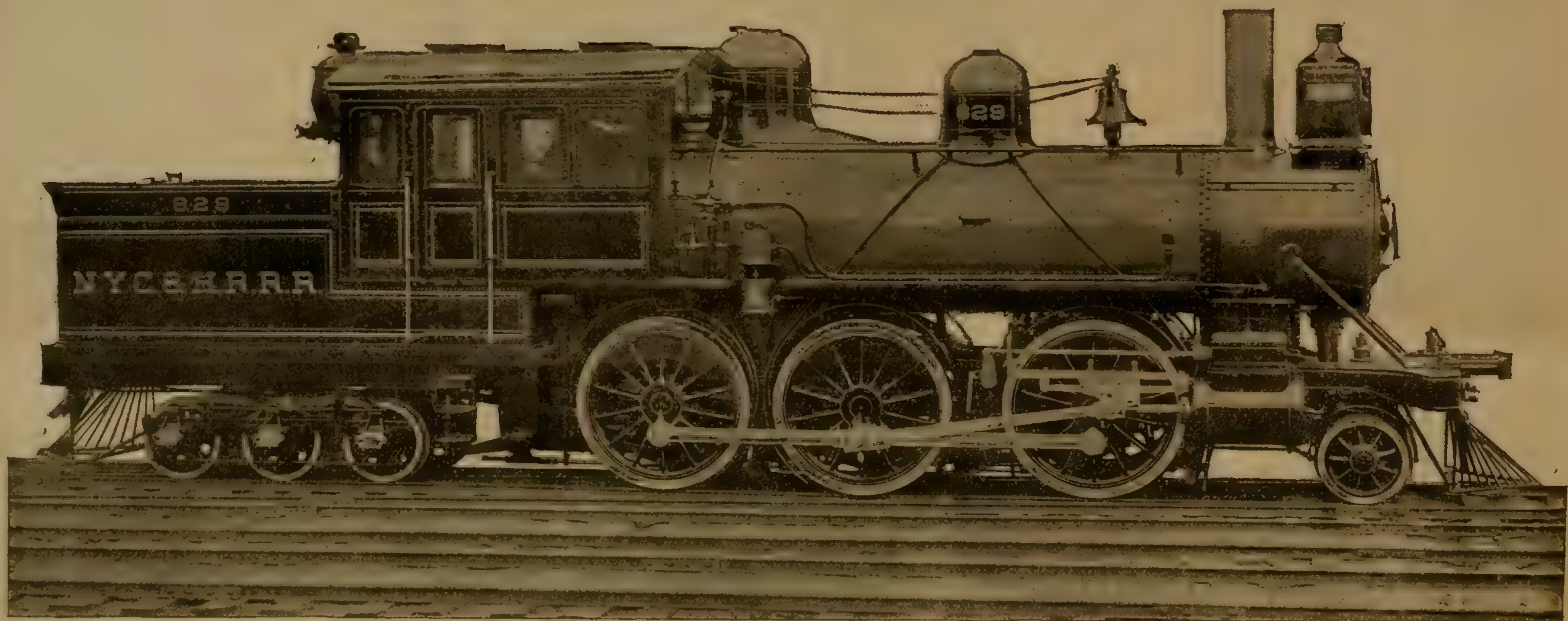
Cruiser No. 12 has not yet been named, and no title has been suggested for her beyond that of the *Pirate*, which has already been attached to her as a popular nickname.

### TORPEDO TRIALS.

A trial of the Sims-Edison torpedo was held at Willet's Point near New York, August 12, the object being to test the steering qualities chiefly. The float of the torpedo was 28 ft. long and the torpedo itself 33 ft. long and 26 in. in diameter. The official report has not been published, but it is understood that the trial was very successful. It lasted about 4½ hours, and at a distance of about two miles the torpedo was entirely under control, turning in a radius of 250 ft. and going through various evolutions.

The engine registered 250 revolutions, and the dynamo reached 400 revolutions. The capacity of the dynamo is 1,800 volts and 30 ampères, of which only 1,300 volts and 23 ampères were used. The power absorbed by the propelling and steering apparatus registered 32 H.P.

The accompanying sketch shows a Sims-Edison torpedo. The body of the torpedo is shown in section. In operation the connections are made by wires from the shore dynamo. The only parts of the apparatus above water are the edge of the float *A A* and the two small signals *B B*, by which the operator on shore is enabled to follow the progress of the torpedo.




TANK LOCOMOTIVE FOR SUBURBAN TRAFFIC, NEW YORK CENTRAL & HUDSON RIVER RAILROAD.

BUILT BY THE SCHENECTADY LOCOMOTIVE WORKS, SCHENECTADY, N. Y.

NEW CONTRACTS.

The Secretary of the Navy has decided to award the contract for Cruiser No. 13 to the William Cramp & Sons Ship & Engine Building Company, of Philadelphia, for $2,690,000, that amount being $55,000 below the Company's first bid. The reasons given for this award were that, while the bid of the Bath Iron Works was the lowest, that Company could not complete the ship as soon as the Cramp yards ; moreover, the Cramp Company was already building Cruiser No. 12, which is almost exactly the same ship as No. 13, and would thus have an advantage in time, having already a large number of patterns, etc., which could be used on the second ship.

## A LOCOMOTIVE FOR SUBURBAN SERVICE.

THE engraving given herewith is from a photograph of one of several new locomotives built by the Schenectady Locomotive Works for the New York Central & Hudson River Railroad. They were designed by Mr. William Buchanan, Superintendent of Motive Power of that road, for the suburban trains out of New York. The work on these trains is very heavy, owing to the numerous stops required, and the necessity of making quick time and frequent runs. The extent of this service and the necessity for making time will be appreciated when it is stated that from 3 P.M. to 7 P.M. a train leaves the Grand Central Station in New York every five minutes, on an average, on the Hudson River and Harlem divisions of the road, while if the trains of the New York, New Haven & Hartford, which also use the Grand Central Station, are added, the average headway is reduced to about three minutes.

This engine, it will be seen, is of the Hudson double-ender type, having a two-wheeled truck forward, six coupled driving wheels under the boiler, and a six-wheeled truck under the tank ; the latter is carried on an extension of the frames. The rear driving-axle is under the fire-box.

The boiler is of the wagon-top type, and is built for a working pressure of 180 lbs. The barrel is 56 in. in diameter. The barrel and outside fire-box are of ½-in. steel ; the circumferential seams are double riveted, and the horizontal seams are quadruple riveted, with welt strips inside. There are 254 iron tubes 2 in. in diameter and 11 ft. long. The fire-box is 108 $\frac{3}{16}$ in. long inside, 42⅝ in. wide, 64¾ in. deep at the front end, and 54¾ in. at the back. The fire-box plates are of $\frac{5}{16}$-in. steel, except the crown-sheet, which is ⅜ in. and the tube-sheet ½ in. The water space around the fire-box is 4 in. in front, 3 in. at the back and sides. The crown-sheet is stayed by crown-bars 5 × ⅝ in. in size and welded at the ends in pairs. The grate, for anthracite coal, is of water-tubes, with the necessary pull-out and shaking bars. The grate area is 31.9 sq. ft. ; the heating surface is : Fire-box, 144.9 sq. ft. ; tubes, 1,451.8 sq. ft. ; total, 1,596.7 sq. ft. The smoke-stack is 15 in. inside diameter, and its top is 14 ft. 6 in. above the rail. The exhaust nozzles are double, and are 3⅝ in. in diameter.

The tank, which is carried on an extension of the frame as shown, has a capacity of 2,300 galls. of water. The coal-box will hold 2¾ tons of anthracite coal.

The cylinders are 18 in. in diameter and 22 in. stroke. The pistons are 5 in. thick, and the packing is the ordinary brass ring babbited and held out by springs. The piston-rods are 3½ in. in diameter. The steam ports are 16 × 1½ in. ; the exhaust ports 16 × 2½ in. The valve motion is the ordinary link ; the valves are the Richardson balanced, and have ⅞ in. outside lap and $\frac{1}{16}$ in. inside lap. The greatest travel of valve is 5½ in., and the lead at full stroke is $\frac{1}{16}$ in. Piston rods and valve stems have the U. S. metallic packing.

The driving-wheels are 64 in. in diameter ; the driving-axle journals are 7½ × 9 in. The front truck is a two-wheeled swinging bolster truck ; the wheels are 30 in. in diameter, and the axle has journals 5½ × 9 in. The back truck is a six-wheeled swinging bolster truck, with 30-in. wheels ; the axles have 4½ × 8 in. journals. The main crank-pins are 4½ × 4½ in. ; the intermediate crank-pin 5 × 5 in., and the front and back crank-pins 4½ × 3½ in. The parallel rods have solid ends and bushings. The driving-springs are 40 in. between centers of hangers, and those of the main and back drivers are hung under the engine frame. The arrangement of the springs on the six-wheeled truck is shown by the engraving.

The transverse distance between the centers of cylinders is 7 ft. The main connecting rod is 7 ft. 4½ in. between centers. The total wheel-base of this engine is 35 ft. 7 in. The rigid wheel-base, which is also the driving-wheel base, is 12 ft. 9 in. The total wheel-base of the drivers and front truck is 20 ft. 4 in. The total weight of the engine ready for service, with tank full, but without coal, is 163,500 lbs., of which 16,000 lbs. are carried on the front truck, 95,000 lbs. on the drivers, and 52,500 lbs. on the back truck. The weight on the drivers is thus 15,833 lbs. per wheel.

Three of these engines have been in service for a short time, and have shown themselves so far very well adapted to their work.

## NOTES ON COMBUSTION.

By C. CHOMIENNE, ENGINEER.

(*Continued from page* 360.)

FIRE-BOXES.

HAVING considered the different qualities of coal, we now proceed to study the phenomena of combustion, and to analyze what happens in the ordinary fire-box of a boiler.

When air passes through a layer of ignited coal, its oxygen takes up carbon in different degrees according to the period of contact. This period, for the same layer of coal, depends upon the speed with which the air passes through it. The stronger the draft, the less time of contact and the less carbon is absorbed by the oxygen.

As the layer of coal upon the grate is never entirely homogeneous, each particle of air passes through it under different conditions of contact, and the composition of the resultant gases will vary from point to point. We find oxygen, carbonic oxide, carbonic acid and finally nitrogen, and to these gases are added the hydrocarbons resulting from distillation when the fire is charged with fresh coal. Let us see what is the theoretical quantity of air necessary for the combustion of 1 kg. of carbon.

In 100 parts by weight of carbonic acid there will be 27.273 of carbon and 72 727 of oxygen. The quantity of oxygen necessary to the combustion of 1 kg. of carbon will be

$$\frac{27.273}{72.727}=\frac{1}{x}, \text{ whence}$$

$$x=\frac{72.727}{27.273}=2.666 \text{ kg.}$$

The weight of one cubic meter of air at 0° (cent.) being 1.3 kg., a cubic meter of oxygen at the same temperature will weigh 1.1054 × 1.3 = 1.437 kg., and the volume of 2.666 kg. of oxygen will be :

$$\frac{1.437}{1.000}=\frac{2.666}{x},$$

$$x=\frac{2.666}{1.437}=1.855 \text{ cubic meters.}$$

Since 100 volumes of air include 21 of oxygen and 79 of nitrogen, the quantity of air necessary to the combustion of 1 kg. of carbon will be :

$$\frac{0.21}{1.0}=\frac{1.855}{x}$$

$$x=\frac{1.855}{0.21}=8.800 \text{ cub. meters.}$$

Applying the same calculation we find that 26.600 cub. meters of air will be required to burn 1 kg. of hydrogen. If we take a gas coal having 82 parts of carbon and 5.4 of

hydrogen per 100, to have a theoretically complete combustion, we will require for

| | | |
|---|---|---|
| Carbon | 0.820 × 8.800 = 7.234 | cub. m. |
| Hydrogen | 0.054 × 26.600 = 1.436 | " " |
| Total | 8.670 | cub. m. |

It is not possible to fix absolutely the quantity of air necessary to combustion, which varies with the quality of the fuel. We can, nevertheless, say that to burn 1 kg. of coal of average quality, it will be theoretically necessary to supply about 8 cub. m. of air.

If we use only the quantity of air strictly necessary, it will require special conditions of combustion which are impossible to realize in practice. It would be necessary, in the first place, to have the coal in small pieces, all exactly of the same size, leaving a great number of passages through the burning mass in order to permit the air to pass through uniformly and to give up all its oxygen; but in practice the coal is in pieces of very unequal size, leaving consequently unequal and variable intervals. The layer of coal is of unequal thickness and the slag more or less porous.

If the air passages are not increased so as to admit a greater quantity of air than is absolutely necessary for combustion, a part of the carbon, instead of being completely oxidized and passing into the state of carbonic acid, is only partially burned and is transformed into carbonic oxide, and we know that these combustions produce widely different heating effects. The combustion of the same body is accompanied by the disengagement of very different quantities of heat according to the amount of oxygen with which it combines in the different cases. In fact, 1 kg. of carbon in passing into the state of oxide has produced experimentally 2,473 calorics or units of heat. Now we know that 1 kg. of carbon and 8 kgs. of oxygen will produce 14 kg. of carbonic oxide. In consequence, 1 kg. of carbon will produce $14 \div 6 = 2.333$ kg. of CO, and as 1 kg. of CO transformed into $CO_2$ develops 2,403 calorics, the 2.333 kg. of CO changed into $CO_2$ will give $2.333 \times 2{,}403 = 5{,}607$ calorics. Consequently the total number of units of heat developed by the combustion of 1 kg. of carbon will be $2{,}473 + 5{,}607 = 8{,}080$.

This would show that 1 kg. of carbon transformed directly into carbonic acid disengages the same quantity of heat as if it were first transformed into carbonic oxide and then into carbonic acid.

There is then a very great advantage in transforming all the carbon into carbonic acid, since under these conditions it develops 8,080 units of heat, while transformed into carbonic acid, which develops only 2,473, or less than one-third. If an insufficient supply of air is injurious to complete combustion of the elements of the coal, on the other hand, an excessive supply of air has the inconvenience of increasing the quantity of hot gases which are thrown out from the smoke-stack, which increases the loss of heat by the chimney, a loss which can increase to a much greater degree than the gain made by obtaining a more complete combustion.

Experience has shown, and it has been generally admitted in practice, with ordinary fire-boxes of steam boilers, that in order to reduce to a minimum the sum of the losses by incomplete combustion and by the chimney it is generally necessary to admit to the grate almost double the quantity of air theoretically necessary, because the oxygen being disseminated in the air, will not be completely absorbed in its passage through the burning coal.

The volumes which pass through the grate are also very variable, according to the moment of combustion. Thus when fresh coal is thrown upon the burning mass there is a rapid disengagement of gas which fills at once all the openings. The passage of air is partly interrupted, but it resumes its rapidity as fast as the smoke disappears and the coal is transformed into coke.

Some experiments on this head are reported by Mr. Combes, who states that he passed through the ash-box 5.340 cub. m. of air, and as the disengagement of smoke diminished the quantity of air entering increased until it was 19 cub. m., when the coal was transformed into coke; that is, when it had parted with its gases.

The current of air is then entirely insufficient during the moments following the charge of the furnace with coal and is too great at other times, but what we wish to produce is directly the opposite. There should be more air at the moment of the disengagement of smoke and less when that has ceased. The best method of remedying this is to burn the coal very carefully, firing in such a way that the production of gas may be as nearly constant as possible. This result may be obtained by firing frequently and with small quantities of coal from the front of the grate where the temperature is higher. The coal then gives up its gases slowly and they burn as soon as produced, and when it is almost transformed into coke, it can be pushed forward in the fire-box where the combustion is completed. This careful method, however, is hardly possible except with the rich or oily coals, the use of which in boilers is becoming less and less general. It is for this purpose that we use the dead-plate, the invention of which is attributed to Watt, which is placed between or at the end of the grate bars, and is a plate upon which coal is placed for distillation. The dead-plate was formerly made much larger than it is now, when it has been reduced in size and is practically only used for the purpose of making a division between the fire and the front plate of the fire-box.

When we use dry coals, which is the most frequent case, the coal can be thrown on uniformly over the whole grate. For a fire-box burning, say, 100 kg. an hour, it would be sufficient to fire about once in 12 minutes, putting in 20 kgs. at a time, and this work would not be excessively fatiguing for the firemen. With a large fire-box burning, say, 200 kg. an hour, and supplied with two doors, the charges could be made alternately at either door and at intervals of about six minutes.

As the grate becomes loaded with slag, the air passes through with some difficulty; especially if the slag is porous, the fuel burns imperfectly and the smoke-stack throws out black smoke with colorless carbonic oxide. In this case it becomes necessary to open the air passages in such a way as to make up for the insufficient supply by the increased draft.

If we use a harder coal with less flame, we avoid the inconvenience of this irregular supply of air, because this fuel will not form slag and will not give out much gas.

According to certain experimenters, the chemical combinations in the fire-box are more complete as the draft is stronger, but with the essential condition that the layer of coal on the grate should be in relation to the activity of the draft. If the fire is too thin, much air will pass through without giving up its oxygen, the tubes or flues will be cooled and heat will be carried off. With a strong draft it is, then, advantageous to burn the coal in a thicker layer.

According to Messrs. Thomas and Laurens, carbonic oxide is only formed when the combustion is slow; that is, when the draft is weak. Their observations have been confirmed by the recent experiments of M. Scheurer-Kestner, of Mulhouse, who has found that with a supply of air more than 50 per cent. in excess of the theoretical quantity, there is still some formation of carbonic oxide, and when the excess of air is only from 6 to 7 per cent., this proportion is enormous and can be increased, as we will see below, to 6 per cent.

Forced draft suits very well hard coals with little flame, especially when we use this coal as it comes without screening. When it is fine it should be mixed with coal tar or some similar material, in order to furnish the gaseous element which is wanting.

M. Poupardin has recently published an account of some experiments which he has made on the use of heated air beneath the grates, and he has succeeded in proving that there is an economy in this which varies from 5 to 7 per cent. This air is heated by means of the hot gases passing into the smoke-stack, and its temperature can be raised to 50° Cent. With heated air, the tubes are not cooled to the same degree, and we obtain a shorter and whiter flame. At the same time the production of smoke is very much diminished.

ANALYSIS OF THE PRODUCTS OF COMBUSTION.

The analysis of the gases given out by a chimney shows that the composition of the gaseous products of combustion

varies very greatly, as the smoke is lighter or darker. The materials composing this smoke are carbonic acid, oxygen, carbonic oxide, hydrogen, nitrogen, and lastly solid carbon in a very finely divided state, held in suspension in steam and the other gases. The quantity of water formed can be estimated as follows: If we take coal having 82 parts of carbon, 5.4 hydrogen and 12.6 of oxygen in 100, the production of the combustion of this coal in water will be $(8 \times 5.4) + 5.4 = 48.6$ kg.

Each unit of weight of hydrogen, in fact, combines during combustion with 8 units of oxygen in order to form 9 units of water in weight. This figure of 48.6 kg. represents about 80 cub. m. of steam at a pressure of 0.76 and at 100° Cent.

As to the black carbon which is thrown out by the chimney, it is found without doubt chiefly in solution in the hydrogen and mixes up in the immense quantity of steam which we have just estimated. It is deposited as soon as the temperature of the smoke is sensibly lowered, which explains the fact that we find it only in the passages beyond the boiler and near the chimney. If we use a strong draft, it is carried through and is deposited beyond the chimney, on neighboring surfaces.

In order that the results of the analysis of the gases may be exact, it is necessary, as M. Scheurer-Kestner has shown:

1. That the gases be taken as far as possible from the fire-box in order that the mixture, which is very different when it leaves the fire-box, may be as homogeneous as possible. It has been observed that in taking the gases in the fire-box we find a quantity of carbonic oxide much greater than that which exists in the same gases when they have cooled somewhat.

2. The gases must be taken at uniform intervals during a considerable time. This is simply saying that to take the gases out irregularly and for a short time only has no value whatever when we seek to determine the average composition.

We give below experiments made on a boiler with three flues with cylindrical reheaters. The principal dimensions are as follows: Length of boiler, 6.60 m.; diameter, 1.20 m.; heating surface, 12 sq. m.; diameter of flues, 0 50 m.; heating surface of flues, 28 sq. m.; total heating surface, 40 sq. m.; length of the superheaters, 7.90 m.; diameter, 0.50 m.; surface, 71 sq. m.; length of the grate, 1.28 m.; width of the grate, 1.40 m.; space between grate bars 8 mm.; total surface of the grate, without dead-plates, 1.79 sq. m., of which 1.28 sq. m. are occupied by the grate bars themselves and 0.51 sq. m. by the air spaces between them.

The coal used had the following composition: Cinders, 21; carbon, 70; hydrogen, 4; oxygen, 4; nitrogen, 1, in 100 parts, and the quantity of air theoretically necessary to burn 1 kg. was 7.145 cub. m. The gases were taken at the end of the boiler in order to avoid any mixture of exterior air. The results of these analyses are given in the accompanying table:

| No. of Analysis. | Air in Excess. | Air introduced under the Grate. | Composition of the Gases in 100 parts. Incombustible Gases. Nitrogen. | Carbonic Acid. | Oxygen. | Combustible Gases. Carbonic Oxide. | Vapor of Carbon. | Hydrogen. | Coal burned per hour per sq. dcm. | Max. Temperature of the Gases. | Quantity of Coal at a Charge. | Interval between Charges. | Loss of Carbon, in Oxide and Hydrocarbons. | Loss of Hydrogen, in a free state and in Hydrocarbons. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Per cent.* | *Cub. m.* | | | | | | | *Kilog.* | *Deg. Cent.* | *Kilog.* | *Min't's* | *Per cent.* | *Per cent.* |
| 12 | 6.66 | 6.504 | 80.38 | 14.87 | 1.41 | 0.84 | 1.15 | 1.35 | 0.400 | 119° | 7 | 5 | 4.1 | 30.9 |
| 11 | 10.47 | 6.803 | 80.60 | 14.16 | 2.18 | 0.97 | 0.98 | 1.11 | 0.470 | 128° | 14 | [illegible] | 5.0 | 26.9 |
| 9 | 13.32 | 7.960 | 80.66 | 14.63 | 2.80 | 0.86 | 0.49 | 0.56 | 0.470 | 126° | 7 | 4 | 5.2 | 15.8 |
| 13 | 17.61 | 8.719 | 81.52 | 13.34 | 3.77 | .... | 0.46 | 0.91 | 0.400 | 135° | 7 | 3 | 6.1 | 17.5 |
| 14 | 20.94 | 8.540 | 80.23 | 13.43 | 4.42 | 0.24 | 0.32 | 1.41 | 0.400 | ? | 14 | 10 | 1.5 | 31.0 |
| [illegible] | 26.18 | 9.257 | 80.34 | 12.89 | 5.53 | ? | 0.28 | 0.96 | 0.230 | 93° | 7 | 8 | 3.9 | 19.7 |
| 10 | 42.84 | 11.718 | 79.76 | 10.87 | 8.99 | ? | 0.19 | 0.19 | 0.925 | 156° | 7 | 2 | 3.4 | 4.7 |
| 7 | 53.78 | 15.393 | 79.86 | 8.23 | 11.35 | ? | 0.04 | 0.52 | 0.166 | 94° | 6 | 10 | 0.9 | 17.7 |

In No. 7 it was difficult to keep the openings in the grate covered with so small a quantity of coal, and for this reason a considerable excess of air is found. In No. 11 and No. 12 the volume of air admitted per kilogram of coal was less than the quantity theoretically necessary to complete combustion—6.86 and 6.50 cub. m. instead of 7.145.

These experiments have established the following facts:

1. Among the gaseous products of combustion, even when there has been always an excess of oxygen, we always find combustible gases, carbonic oxide, hydrocarborns and free hydrogen.

2. In varying the draft and consequently the admission of air to the grate, the loss with the coal used may vary from 6 to 18 per cent. with 8 to 9 cub. m. of air per kilogram of coal; 4 to 6 per cent. with 10 to 12 cub. m., and 1.5 per cent. with 15 cub. m.

The average of the tests made gives the following as the division of the units of heat developed:

| | | |
|---|---|---|
| Calorics in the steam produced | | 63.6 |
| " carried into the chimney by the gases | | 5.1 |
| " lost by incomplete combustion of gases | 4.9 | 5.3 |
| " lost in the soot deposited | 0.4 | |
| " of the steam carried off in the smoke | | 3.0 |
| " not recovered | | 23.0 |
| Total heat from the coal | | 100.0 |

These results have been obtained under exceptional circumstances, and with good firemen. We learn from them what may be the loss in ordinary working when probably the boiler is not placed in the best way, when the fireman is ignorant and left to himself. We see that the loss by incomplete combustion of gases is 5.3—that is, 8.3 per cent. of the useful heat. We may estimate that this loss will generally exceed 15 per cent., that it often reaches 20 per cent., and that it is never less than 10 per cent., if the coal is not anthracite.

The loss of 23 per cent. in units of heat not found was reduced to 17 per cent. with English coal, giving very little smoke and only traces of combustible gases. Even when reduced to 17 per cent., however, the loss is still great, and considering all the facts recorded, we can only attribute it to the radiation of heat to the masonry walls of the fire-box. Boilers with interior fire-boxes, like marine boilers, show some loss by cooling and radiation from the outside surfaces, but it is much less considerable than with the ordinary cylindrical boiler set in masonry.

(TO BE CONTINUED.)

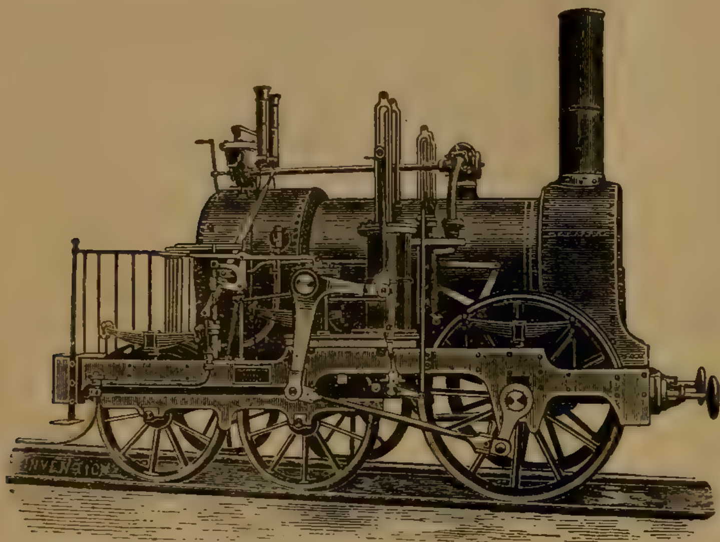
## A BIT OF LOCOMOTIVE HISTORY.

THE accompanying engravings and the description below have been sent us by Mr. Clement E. Stretton of Leicester, England, and are taken from an article published by him in the London *Invention*. The first is from a photograph—believed to be the only one now in existence—of the locomotive *Earl of Airlie*, No. 1, which is described as follows: "This engine was built by Carmichael & Company, of Dundee, Scotland, and commenced work upon the Dundee & Newtyle Railroad, September, 1833, and during the same month the *Lord Wharncliffe*, No. 2, was completed; followed by the *Trotter*, No. 3, in March, 1834.

"These three engines were in every respect similar, and had a single pair of driving-wheels 4 ft. 6 in. in diam-

eter placed in front, and a four-wheeled bogie, the cylinders being vertical, 11 in. in diameter, and the stroke 18 in. Weight of engine in working order without tender, 9 tons 10 cwts.; cost of engine without tender, £700; gauge of railway, 4 ft. 6 in.

"The *Earl of Airlie* appears to have worked satisfac-



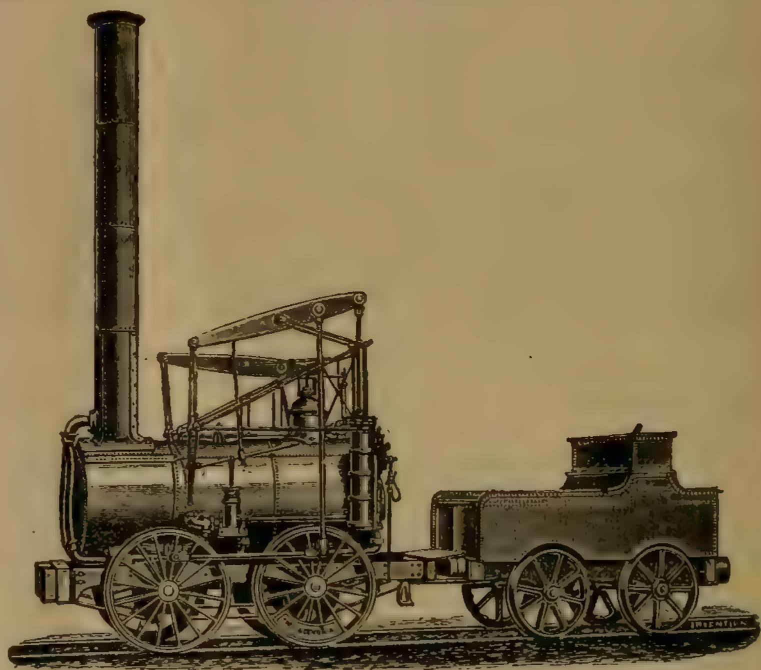
LOCOMOTIVE FOR THE DUNDEE & NEWTYLE RAILWAY, 1832.

torily until 1850, when it was employed to pump water as a stationary engine. In 1854 Mr. Allan, when Locomotive Superintendent of the Scottish Central, had it properly cleaned, painted and photographed, and it is from this photograph that our illustration is produced."

The general design of the engine, with the truck, with its upright cylinders and the bell-crank used to make connection with the driving-wheels, is well shown in the cut.

The second illustration shows a still older engine, which Mr. Stretton describes as follows: "Messrs Foster, Rastrick & Company, in 1829, constructed an engine at their works, Stourbridge, for the Shutt End Railroad, which extends from the Earl of Dudley's Colliery at Kingswinford to the Staffordshire & Worcestershire Canal; this locomotive was named *Agenoria*, and opened the line on Tuesday, June 2, 1829.

"This engine has upright cylinders working half-beams, thus reducing the stroke of the pistons to the cranks. The cylinders are 7½ in. diameter, with a stroke of 3 ft. There is a parallel motion to the piston-rod, and the feed-pump is worked from one of the half-beams. The fire-grate is within a large tubular boiler, branching into two tubes, with the chimney at the end of the boiler, the barrel of the boiler being 10 ft. long and 4 ft. diameter. The eccentrics for driving the slide valves are loose upon the axle, with a clutch to drive either way, and there is hand-gear to the valves to cause the axle to turn half round to bring the required backward or forward clutch into action. The exhaust steam is discharged into the chimney, which, it may be mentioned, is of unusual height. *Agenoria* continued in regular work for fully 30 years, and is now preserved in the South Kensington Museum."



LOCOMOTIVE "AGENORIA," BUILT IN 1829.

It will be observed that the *Agenoria* must have been built immediately before or after the *Stourbridge Lion*, which the late Horatio Allen bought from Foster, Rastrick & Company in 1829, for the Delaware & Hudson Canal Company, and which was the first engine run in this country. Very probably the two were in the shop about the same time. Those who have seen drawings or engravings of the *Stourbridge Lion*,* will at once see that the *Agenoria* was of almost identical design. It is interesting to know that this early specimen of locomotive construction is still preserved as a relic.

## THE HATTERAS LIGHTHOUSE.

THE great caisson which was to serve as the foundation for the lighthouse on Diamond Shoal, off Cape Hatteras, was towed into position successfully on July 1. Operations for sinking were begun, with fair prospects of success, but on July 8 a severe storm came up and the caisson was overturned into deeper water. When the storm was over it was found that the great cylinder was in such a position that its recovery was practically impossible, and the contractors, Anderson & Barr, have decided to build a new one. The loss was partly due to the fact that the water over the shoal was deeper than had been expected, and the foundation looked for was not found. The sandy bottom at that point is constantly shifting, and the depth of water was from 22 to 25 ft., where only about 10 or 12 ft. had been shown by previous surveys.

The caisson lost was a steel cylinder 54 ft. in diameter and 50 ft. long. It was built at Norfolk and towed to the spot where it was to be sunk. The work of getting it into position was accomplished with less difficulty than had been expected.

The contractors will build a new caisson and resume the work as soon as possible. This will take some time, however, especially as it will be impossible to place the caisson during the fall or winter, owing to the constant stormy weather and heavy seas along the coast.

Once in position, the caisson is to be filled in with concrete and surrounded by riprap. The lighthouse will be built on top of it when the foundation is finished. Owing to the constant interruption by stormy weather, it is impossible to say when the lighthouse will be completed, but the new caisson cannot be finished and put in place before next summer, so that at least one year's delay has resulted from the accident.

* See the RAILROAD AND ENGINEERING JOURNAL for February, 1890, page 85.

## THE MORANDE BRIDGE OVER THE RHONE.

THE accompanying illustration, fig. 1, which is taken from *Le Genie Civil*, shows the new Morande Bridge over the Rhone at Lyons, France. The bridge is an arch bridge of three spans resting on two abutments and two piers of granite masonry. The piers are built upon caissons sunk by the compressed air process, the foundations being about 45 ft. below low water. The arches at the center have a clear height of 26 ft. above high water.

Fig. 1.

THE MORANDE BRIDGE OVER THE RHONE.

Each span is composed of eight iron trusses, spaced 8.5 ft. between centers, except the two outside trusses, which are 10.8 ft. from the adjoining inside truss. The total width of the bridge is 65.6 ft., divided into a roadway 36 ft. in width and two sidewalks, each 14.8 ft. wide. The central arch has a span of 221 ft., a rise of 14.6 ft., and a radius of 426.8 ft.; the two side arches have each a span of 210 ft., a rise of 13 ft., and a radius of 418.5 ft. The division of the total space between the arches was calculated in such a way as to equalize the pressure on the piers at an average temperature and the strains on the adjoining arches. The profile of the bridge roadway is an arc of a circle of 17,075 ft. radius, and the grade at the point where it meets the quay on either side is 0.2 per cent. The arch trusses rest at either end upon inclined bedplates of iron, placed on suitable beds on pier or abutment.

Fig. 2.

The bridge carries one of the chief avenues of the city, on which there is a large traffic, including many heavy wagons. The water and gas-pipes are suspended beneath the roadway.

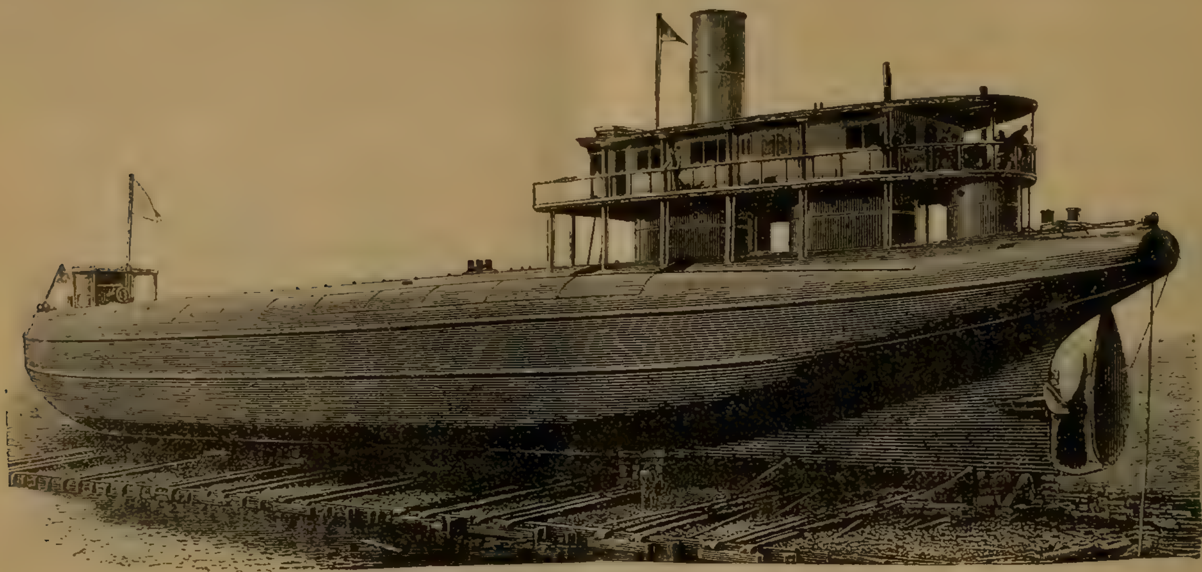
Fig. 2 shows the old bridge which is replaced by the new structure. This bridge was built by the Architect Morande in 1774, and was a wooden structure, consisting of 17 spans, varying from 35 ft. to 45 ft. These spans were simple trusses entirely of oak, and rested on piers composed of groups of oak piles driven into the bed of the river, which is chiefly gravel. This bridge had stood over 100 years, but its width, only 42 ft. in all, and its sharp grades were a serious obstruction to travel, and it had at last begun to show signs of weakness. Its numerous piers, moreover, and the rip-rap used to protect them, constituted an impediment to the boats navigating the river and an obstruction to the free passage of the water in times of flood. The bridge, nevertheless, had done good service and had a long life for a wooden structure.

## THE "WHALE-BACK" STEAMER.

THE "whale-back" steamer *Charles W. Wetmore*, built by the American Barge Company, at Duluth, Minn., has succeeded in making a voyage across the Atlantic and back in spite of some unfavorable predictions. The *Wetmore*, after a trip through the Lakes and down the St. Lawrence, left Montreal with 90,000 bushels of grain on board, and reached Liverpool after a voyage of 15 days. No attempt at speed was made, and the total consumption of coal was only 230 tons. From Liverpool she sailed to New York, and is now loading machinery at the Continental Iron Works. When ready she will sail for a voyage around the Horn to Tacoma, Washington, and will then probably be employed on the Pacific coast.

The *Wetmore* is very similar in construction to the *Colgate Hoyt*, which was described and illustrated in the JOURNAL for September, 1890, page 427. The accompanying illustration we have reproduced from the London *Engineer* because it shows very well the general form and design of the boat. She is 265 ft. long, 38 ft. beam and

24 ft. deep, and can carry 3,000 tons of grain on 16½ ft. draft. Arrangements for carrying 800 tons of water as ballast are provided. The general form is shown by the cut; there is no deck really, and three turrets, the two after ones being connected by a platform or deck. There is a collision bulkhead forward and another bulkhead in front of the engine-room aft, the space between the two bulkheads being entirely free and open for cargo.



THE "WHALE-BACK" STEAMER "CHARLES W. WETMORE."

The engine of the *Wetmore* is a compound, with cylinders 26 in. and 50 in. in diameter and 42 in. stroke. They have worked up to 800 H.P. Steam is furnished by two steel boilers 11½ ft. in diameter by 11½ ft. long, which carry a working pressure of 125 lbs.

On the lakes these whale-back boats have done well in service; they are economical to build and run, and carry very large cargoes. Opinions are widely divided as to their merits as sea-going boats, and the question can be decided only by experience. Probably they can never be made good passenger boats, but they may find a very useful place as ocean freight carriers.

## SOME CURRENT NOTES.

IN pig iron production, according to the tables of the *American Manufacturer*, there is a continued increase. On August 1 there were 302 furnaces in blast with a weekly capacity of 174,502 tons; an increase of five furnaces and 7,078 tons capacity over July 1. As compared with August 1, 1890, there is a decrease of 19 in the number of furnaces in blast, but an increase of 10,435 tons in the weekly capacity.

The gain in August was almost entirely in the bituminous and coke furnaces, the anthracite and charcoal furnaces showing but little change.

ON the Grazi-Tsaritsin Railroad in Russia, where liquid fuel is used, Mr. Thomas Urquhart writes to the London *Railway Engineer* that on the freight trains the average consumption, by careful experiment, has been 0.04824 lb. per ton-mile of gross train, including engine and tender, or 0.0888 lb. per net ton-mile of freight carried. On passenger trains, at an average speed of 25 miles an hour, the consumption was 0.0636 lb. per ton-mile of train, including engine and tender. The fuel used is petroleum from the Baku wells.

ONE of the best pieces of new railroad ever opened for traffic in this country will be the Lehigh Valley line from Waverly to Buffalo. It is double track throughout, has been located and built with great care, and has no grades over 21 ft. to the mile, making it an excellent freight line. It will be opened by May, 1892, at which time the present contract, under which the Lehigh Valley trains run from Waverly to Buffalo over the Erie tracks, will expire. The line could be brought into use sooner, but the road-bed will then have passed through one winter, and will be well settled, and an opportunity will be given to remedy any defects. The Lehigh Valley now has 41 locomotives in service on the Erie tracks, but on the new line a considerable increase in traffic can be handled with the same motive power. The Company has had terminal facilities of its own in Buffalo for some years; and has lately built shops there, which are patterned after the well-arranged shops at Sayre.

THE great dam across the Colorado River at Austin, Tex., is now making substantial progress. This dam will be, when completed, 1,150 ft. long, 60 ft. high, and 18 ft. wide at the top. The up-stream face is of limestone, and is vertical; the down-stream face is of Texas granite, and the interior is rubble masonry, of small stone and cement. There will be about 9,000 cub. yds. of granite, 6,800 cub. yds. of limestone, and 55,000 cub. yds. of rubble in the dam. The estimated cost of the dam itself is $465,000; to this is to be added that of the gate-house, the canal which is to convey the water to the manufacturies, and other auxiliary works, which is estimated at about $800,000 more.

The dam is intended to utilize the power of the Colorado River. The water power will run the electric light plant, furnish power for electric railroads, and for pumping the water-supply of the city, and leave a surplus of some 13,000 H.P. for the use of factories. It is about two miles above the city of Austin, and the natural conditions are very favorable, as the river there runs between high bluffs and the bed is of rock, so that very little excavation is required to find a solid foundation. It will be the largest power dam yet built in this country.

ANOTHER large dam is under construction in California, where the Bear Valley Irrigation Company has undertaken to form a large reservoir in a mountain valley or basin known as the Nuevo Laguna. The dam closing the outlet of this valley will be of earth riprapped on the up-stream face, and will only be 20 ft. in height and 400 ft. long. It will be 150 ft. through at the base, and will not cost over $150,000. In addition to the water brought down by the San Jacinto, the surplus waters of the Whitewater and Santa Ana rivers can be turned into the basin;

it is thought also that an additional supply can be had by boring artesian wells. The supply from the rivers, as stored by the dam, will be sufficient, according to the company's estimate, to irrigate 125,000 acres of land. It is expected that the dam will be completed in time to store the supply from next winter's rains.

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THE Rapid Transit Commission in New York has recommended an additional underground line, to diverge from the main line already proposed at Union Square and thence running under Madison Avenue to 96th Street. The low ground north of that point will be crossed by a viaduct, on private property 100 ft. from the avenue to 134th Street, where the Harlem River will be crossed by a bridge; north of the river no definite line is laid down. Like the main line the new one is to have four tracks, both in the tunnel and on the viaduct, and the motive power will be the same.

The Commission's engineers have nearly completed the surveys and plans for the main line recommended some time ago. As heretofore stated, the plans are for four tracks underground from the Battery to Fort George, above High Bridge. From that point to Kingsbridge, the northern point of Manhattan Island, and thence to the city line the road will be alternately in tunnel and on viaduct, according to the nature of the surface, which is very uneven.

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THE United States Circuit Court in New York has given a decision sustaining the validity of the Edison patents on incandescent lights. This decision practically gives Mr. Edison a monopoly in incandescent lights. The case will be carried up to the Supreme Court.

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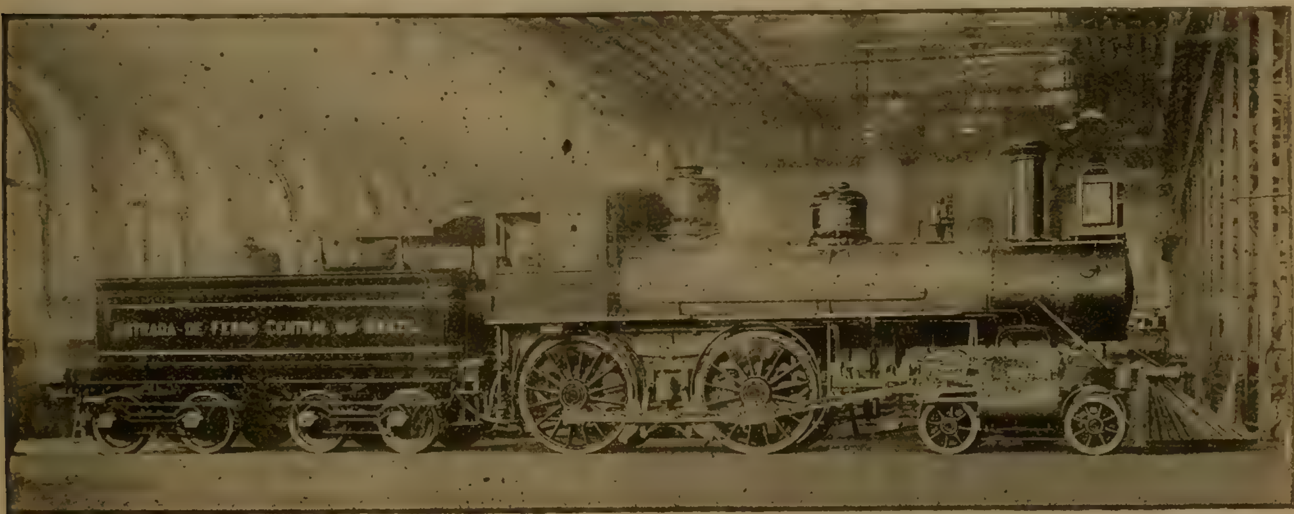
## A FOUR-CYLINDER COMPOUND PASSENGER LOCOMOTIVE.

THE accompanying illustration, which is from a photograph taken in the shop, shows a four-cylinder compound locomotive of the Vauclain type, built by the Baldwin Locomotive Works, in Philadelphia, for passenger service on the Central Railroad of Brazil. The engine is of the ordinary eight-wheel, or American pattern, with four driving-wheels coupled and a four-wheeled truck.

The road is of 5 ft. 3 in. gauge. The high-pressure cylinders are 11½ in. in diameter and the low-pressure cylinders 19 in., all being 24 in. stroke. The driving-wheels are 66 in. in diameter, having Krupp steel tires 2½ in. thick. The driving-wheel-base is 8 ft. 6 in., and the total wheel-base of the engine is 23 ft. 0¼ in. The total weight in working order is 92,000 lbs., of which 60,000 lbs. are carried on the drivers and 32,000 lbs. on the truck.

The boiler is of the wagon-top pattern, and is of ½-in. steel, the barrel being 54 in. in diameter at the smoke-box end; the smoke-box is extended. There are 219 tubes 2 in. in diameter and 11 ft. 6 in. long. A departure from the usual practice is seen in the fire-box, which is of copper, except the crown-sheet. The side and back sheets are ½ in. thick, and the tube sheet ⅞ in. The crown-sheet is of ⅜-in. steel, and is supported by crown-bars in the ordinary way. There is a fire-brick arch supported by water-tubes. The grate is of water-tubes with intermediate pulling-bars. The fuel used will be Cardiff coal imported from England, which is in general use on the Brazilian lines, the country itself producing no coal.

As will be seen from the engraving, the high-pressure cylinder is placed above the low-pressure. The valves are piston valves of the Vauclain pattern, with a shifting-link



FOUR-CYLINDER COMPOUND LOCOMOTIVE, VAUCLAIN PATTERN.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

motion. Both piston-rods are connected to the same cross-head, which is of wrought iron.

The driving-axles are of Siemens-Martin steel, and have journals 7½ in. in diameter and 8½ in. long. The bearings are of phosphor-bronze.

The truck is a swing-bolster truck with four 30-in. wheels; the wheels are cast-iron centers with steel tires. The axles are of steel, with 5 × 9-in. journals.

The tender is carried on two trucks, each having four 36-in. chilled wheels. The tender frame is of iron. Both trucks are center-bearing, and have iron frames. The axles are of steel, with 4 × 7-in. journals. The tank will hold 3,000 galls. of water. The weight of the tender, with a full load of water and coal, is 66,000 lbs.

It may be noted that the ratio between the high-pressure and low-pressure cylinders is 1 : 2.73.

A large number of the Vauclain compound locomotives are now in progress at the Baldwin Works, of which the engine illustrated is one of the best examples.

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### Foreign Naval Note.

IN a recent trial in France, before a commission of Russian officers, ten rounds were fired from a 15-cm. Canet gun in 100 seconds. This 15-cm. gun is 45 calibers in length; the projectile weighs 88 lbs., and the charge used is from 21 to 26.5 lbs. of smokeless powder. On a second trial, using powder charges of 22.2 lbs., seven rounds were fired in 54 seconds. With a projectile weighing 88 lbs. and a powder charge of 24.3 lbs., a muzzle velocity of 2,497 ft. was reported. A 12-cm. Canet gun, 45 calibers in length, fired nine rounds in 45 seconds; the projectiles weighed 44.5 lbs., and the powder charges were 12.1 lbs. With a shell weighing 46.8 lbs. and a charge of 12.1 lbs. of powder in the 12-cm. gun, a muzzle velocity of 2,487 ft. was reached.

## THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.



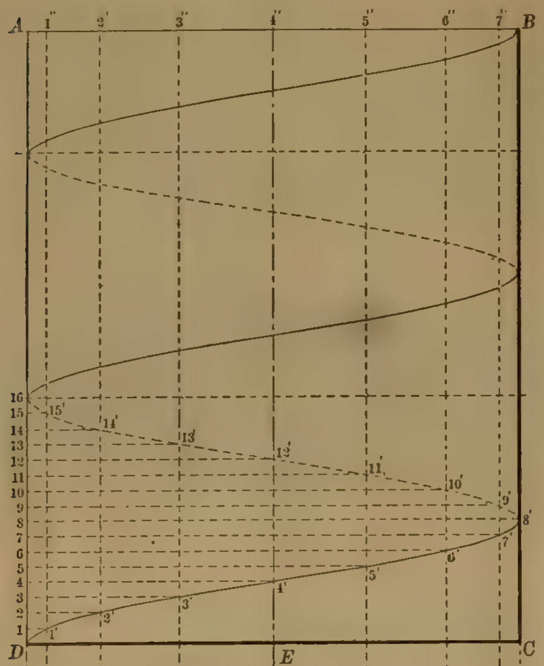
(*Continued from page* 376.)

### CHAPTER XII.—(*Continued.*)

### THE HELIX.*

The helix or, as it is sometimes though improperly termed, the spiral, is the curve described upon the surface of a cylinder by a point revolving round it, and, at the same time, moving parallel to its axis by a certain invariable distance during each

Fig. 306.



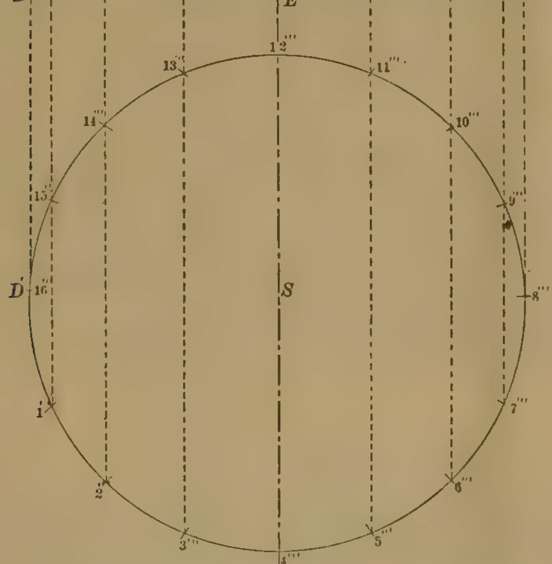




Fig. 307.

revolution. Thus the outlines of the thread of a screw and of what are called spiral springs form helixes.

Thus let it be supposed that the cylinder *A B C D*, fig. 306, has been placed in a lathe with its axis coincident with the lathe "centers," and a sharp-pointed turning tool is placed in contact with the surface of the cylinder at *D*, and that while the cylinder turns one revolution the tool moves from *D* to 16 at a uniform speed. The point of the tool would then describe a helix *D*, 1′, 2′–8′–16 on the surface of the cylinder, which would be of the form of the thread of a screw. The distance *D* 16 which the curve advances on the cylinder during each revolution, as described in Chapter VI, is called its pitch.

Problem 114. *Required to draw a projection of a helix which is described around a cylinder.*

If *A B C D*, fig. 306, be the cylinder, then if the helix begins at *D* and *D* 16 is equal to the pitch, divide the latter into any even number of equal parts—in this case 16. Then on the center line 4″ *E* extended, and from any convenient point, as *S*, fig. 307, for a center, draw a circle whose diameter is equal to that of the cylinder, and divide its circumference into the same number of equal parts, 1‴, 2‴, 3‴, 4‴, etc., as the pitch has been divided into. Project these points in fig. 306 by vertical lines 1‴ 1″, 2‴ 2″, 3‴ 3″, etc., to *A B*. In winding around the cylinder from *D′* to 1‴, fig. 307, and from *D* to 1′, fig. 306, or one-sixteenth of the circumference of the cylinder, the helix has moved in a direction parallel to the axis of the cylinder a distance equal to *D*, or one-sixteenth of the pitch. Consequently, if we draw a horizontal line from the point 1—whose distance from *A* is equal to a sixteenth of the pitch—to 1‴ 1″, the point of intersection 1′ will be a point in the projection of the curve. Similarly by projecting the point 2‴, fig. 307, by the line 2‴ 2″ and by drawing a line 2 2′, we will have another point 2′ in the curve. The other points 3′, 4′, 5′, 6′, 7′, etc., may be laid out in a similar way. In advancing half way around the cylinder, or from *D* to 8′, in fig. 306, and *D′* to 8‴, in fig. 307, the helix has moved parallel to the axis of the cylinder a distance equal to half the pitch. From 8′ to 16, in fig. 306, and 8‴, 9‴, 10‴–*D′*, in fig. 307, it has advanced another half of the pitch.

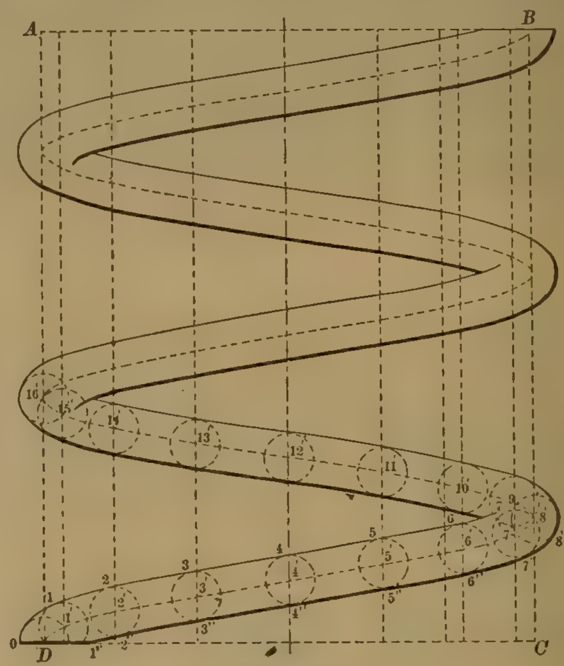



Fig. 308.

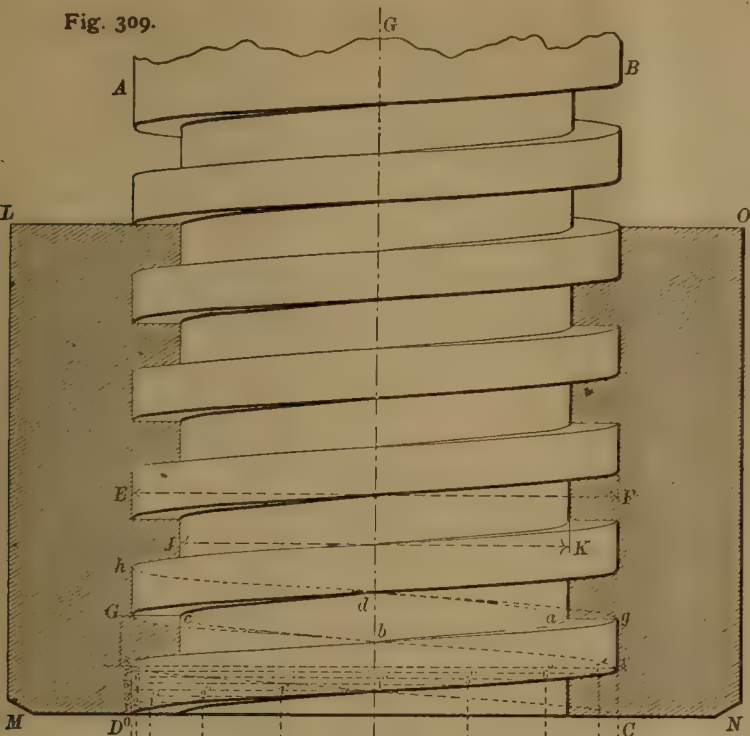
This latter portion of the curve is behind the cylinder in fig. 306, and is therefore represented by a dotted line, 8′, 9′, 10′–16, and is of exactly the same form as *D*, 1′, 2′–8′, but is reversed in position. It is drawn in the same way as has been described. As the projection of each succeeding revolution of the helix is the same as the first, if we make a template of *D* 1′ 2′–8′, all the other convolutions of the curve can be drawn from it.

Problem 115. *To draw the projection of a helical spring.*

Let it be supposed that the spring is made of a round bar of steel, and that the diameter of the helix, measured from center to center of the steel, is the same as that of the cylinder shown in fig. 306, and that the pitch is also the same as that of the helix in this figure; then the first thing to do is to draw a helix *D*, 1′, 2′–8′, 16′, fig. 308, representing the center line of the steel bar. Next, with a radius equal to half the diameter of the bar, describe circles from the points *D*, 1′, 2′, 3′, etc., and draw lines 0, 1, 2, 3, 4, etc., and 1″, 2″, 3″, etc., tangent to these circles. The lines thus drawn will represent the outline of the spring.

* Draw the figures in this chapter double the linear scale to which they are engraved.

Fig. 309.



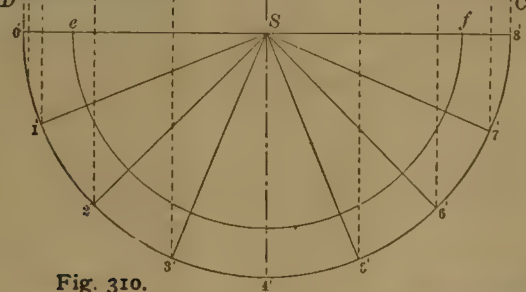




Fig. 310.

PROJECTION OF A SCREW-THREAD.

In Chapter VI the ordinary method of drawing a screw-thread was described. It was there explained, however, that that method does not represent screw-threads correctly, as the outlines of screw-threads are helices and not straight lines, and therefore the outlines of the thread of a screw in a side elevation will be slightly curved.

PROBLEM 116. *To draw the projection of a square-threaded screw.*

Let *A B C D*, fig. 309, be a screw whose diameter is equal to *E F*, and whose pitch equals *D G*. From a point *S* on the center line *G S* extended, draw a semicircle whose diameter is equal to that of the screw or *E F*. Subdivide the semicircle into any number of equal divisions 0′, 1′, 2′, 3′, etc.—in this case eight. Bisect the pitch *D G* and divide one-half of it into the same number of equal parts 0, 1, 2, 3, etc., as the semicircle has been divided into. Project vertical lines from the points of division 1′, 2′, 3′, etc., in the semicircle, and horizontal lines from 1, 2, 3, etc., the points of division of the pitch; then the points of intersection 1″, 2″, 3″–8″ will be points in the projection of the screw-thread. As all the threads are alike, by making a template of the curve 0, 1″ 2″–8″ the outline of all the other threads can be drawn with it if the lines *A D* and *B C* are each subdivided into divisions equal to half the pitch. The curves *a b* and *c d*, which represent the root of the thread, or rather its junction with the body of the screw, may be drawn by constructing a helix on a cylinder whose diameter is equal to *J K*, or the diameter of the screw at the root of its thread. To do this a second circle is drawn from the center *S*, whose diameter *e f* is equal to *J K*. The method which has been explained for drawing the outline 0, 1″ 2″–8″ must then be employed for drawing *a b* and *c d*.

In fig. 309 a section *L M N O* of a nut is shown on the screw, an outside view of the screw being represented. In this view the edges 0–8″ and 8 *g* of the thread which are nearest to the observer are shown. In making a half of a revolution the thread would advance from *D* to 8″, and in turning completely around the screw it would pass behind the screw and would advance from 8″ to *G*. The outside edges of this part of the thread which is behind the screw are represented by the dotted lines 8″ *b G* and *g d h*. It will be noticed that these incline the reverse way to the portion of the thread nearest to the observer. If now we were to remove the screw from the section of the nut and show the latter without the screw, the grooves in the nut in which the threads work would be seen, which are counter-parts of the thread. Consequently in showing such a section of a nut its thread is represented as shown in fig. 311. The construction for delineating the lines which represent the roots of the thread is shown in this and the following figure, which will require no further explanation.

## CHAPTER XIII.

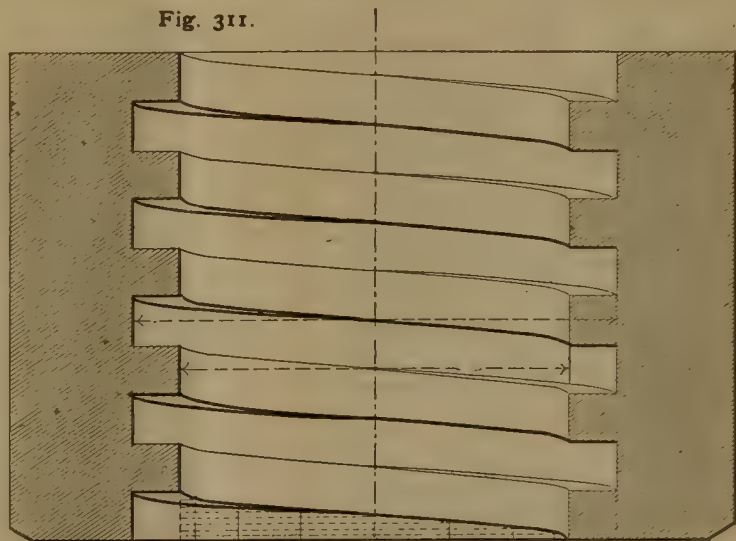
### ENVELOPES OR COVERINGS OF SOLIDS.*

BOILERS, pipes, tanks, and vessels of different kinds are usually made of sheets or plates of metal which are fastened together so as to form structures of various geometrical forms. In designing them it is essential to lay off the plates so that they would cover solids of the form of the inside of the structure composed of the plates. Some of the most ordinary problems of this kind which a draftsman is called upon to solve will therefore be elucidated.

PROBLEM 117. *To lay off the envelope of a cylinder.*

Let *a b c d*, fig. 313, represent a side view cylinder 8 in. in diameter and 10 in. long. The

Fig. 311.



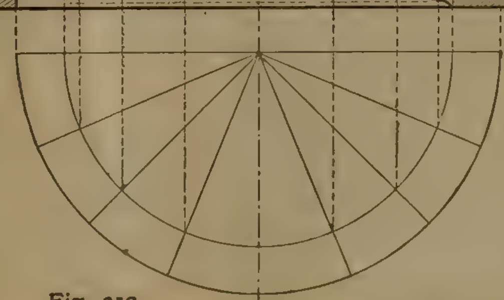
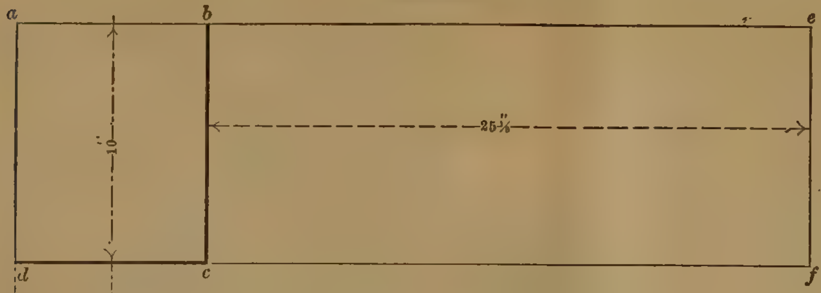


Fig. 312.

* Draw the figures in this chapter double the linear scale to which they are engraved.

Fig. 313.



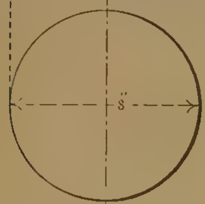


Fig. 314.

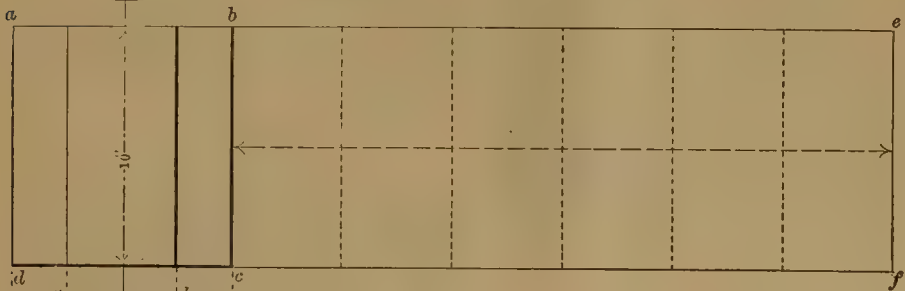


Fig. 315.

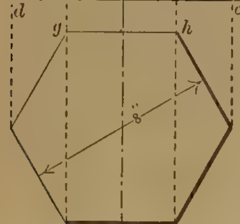


Fig. 316.

width of an envelope to cover the outside of the cylinder must obviously be equal to its height. Therefore extend the lines *a b* and *d c*, representing the top and bottom of the cylinder, which will define the width of its envelope. Obviously, too, its length must be equal to the circumference of the cylinder. Therefore either calculate the length of the circumference, or ascertain it from a table of diameters and circumferences, and lay it off from *b c* to *e* and *f*, and draw *e f* perpendicular to *b e* or *c f*; then *b e f c* will represent the envelope of the outside of the cylinder. For its ends draw a circle, fig. 314, equal to its diameter, and it will represent a cover for the ends.

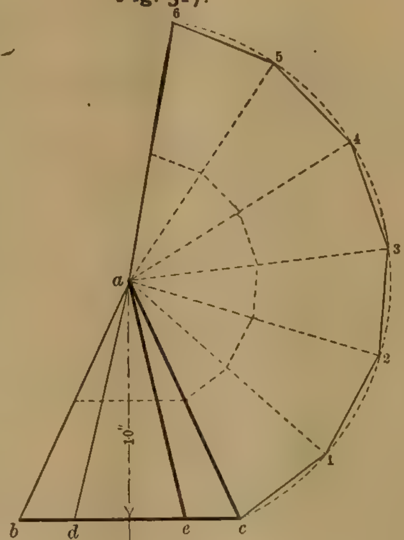
PROBLEM 118. *To lay off an envelope for a prism.*

Let it be supposed that the prism *a b c d* is six-sided. First draw a plan of it, fig. 316, and a side view, fig. 315. As in the case of the cylinder, extend the lines *a b* and *d c* to represent the upper and lower edges of the envelope. Then, from the plan, take, with a pair of dividers, the length *g h* of one of the sides of the prism. From *b c* step off six times the length of the side on *b e* or *c f* and draw *e f*; then *b e f c* will be the envelope for the sides. The plan, fig. 316, will represent the cover for the top and bottom.

PROBLEM 119. *To draw the envelope of a pyramid.*

Let *a b c*, fig. 317, be a side view of a six-sided pyramid, and fig. 318 a plan.

Fig. 317.



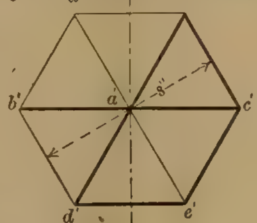


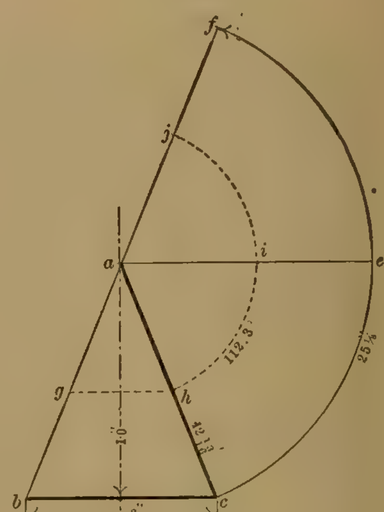
Fig. 318.

It is obvious that the cover of any one side, as *a c e*, represented by *a' c' e'* in the plan, is bounded or enclosed by the edges *a c*, *a e*, and *e c*. Consequently if the line *a c* is supposed to represent one side of the envelope if we take *a c* as a radius and describe an arc at 1, and with *e' c'* as a radius and *e* as a center, we intersect the first arc at 1 and draw *a* 1, then the area *a c* 1 will represent the cover for the side *a e c*. Continuing in the same way, if we describe intersecting arcs at 2 with the same radii and *a* and 1 as centers, we will have the area *a* 1 2, which will be the cover for the side *a d e*. In the same way the whole area *a c* 1 2 3 4 5 6 may be completed, which will be the envelope of the sides of the pyramid. A continuous arc *c* 1 2 3 4 5 6 may be drawn, and the length *e' c'* or *d' e'* of one side of the base can then be set off six times from *a* on this arc, and if straight lines *c* 1, 1 2, 2 3, etc., are drawn through these points and drawing *b a* the envelope will be completed. The cover for the base will be the hexagon shown in the plan.

PROBLEM 120. *To draw the envelope of a cone and of a frustrum of a cone.*

If *a b c*, fig. 319, is a side view, and fig. 320 a plan of the cone, then any line, as *c' a'* or *d' a'*, drawn from the circumference of the base to the vertex *a* on the cone itself will be equal to *a b* or *a c*. Consequently if with *a* as a center and *a c* as a radius, we describe an arc *c e f*, and if we make this arc equal in length to the circumference of the base and

Fig. 319.



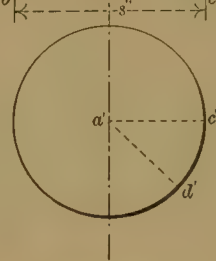


Fig. 320.

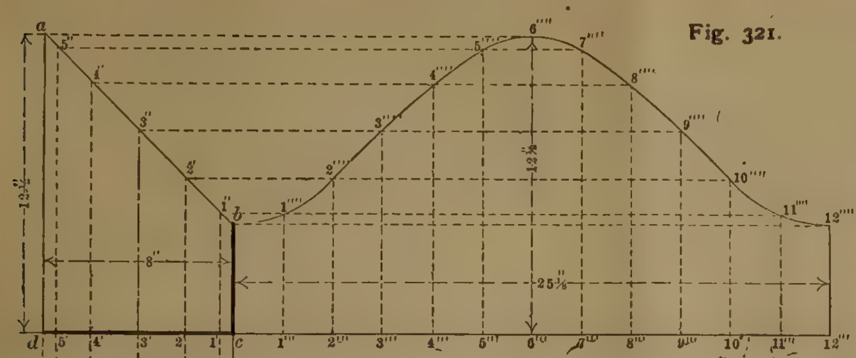


Fig. 321.

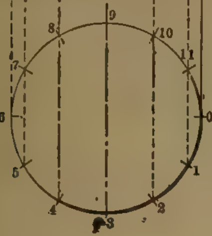


Fig. 322.

draw $f\,a$, then $c\,e\,f\,a$ will form an envelope for all of the cone excepting its base. The distance $c\,e\,f$ may be laid off approximately by taking a distance equal to 1 in. in a pair of dividers and then stepping off from $c$ on $c\,e\,f$ a number of inches equal to the circumference of the base; or get the length of the side $a\,c$ and the circumference of which it is the radius. Then divide 360 —the number of degrees in a circle—by this circumference, and multiply by the circumference of the base. The quotient will be the angle $c\,a\,f$. Lay off this angle and draw $a\,f$; then $f\,e\,c$ will be equal in length to the circumference of the base.

To lay off the envelope for a frustrum of a cone $h\,c\,b\,g$, first draw the envelope for the whole cone $a\,b\,c$. Then draw that $a\,h\,i\,j$ for the small cone $a\,g\,h$. Then the difference between $a\,c\,e\,f$ and $a\,h\,i\,j$ or $h\,c\,e\,f\,j\,i$ will be the envelope of the frustrum. The covers for the base and top will be circles whose diameters are equal to $b\,c$ and $g\,h$.

PROBLEM 121. *To find the envelope for a cylinder a b c d, fig. 321, having one of the ends a b cut off at an angle to its sides a d and b c.*

Draw a plan, fig. 322, below the side elevation, and divide the circumference into any number of equal parts—in this instance twelve—and through these points draw vertical projection lines to $a\,b$. Extend the base $d\,c$ to 12''', and make $c$–12''' equal to the circumference of the cylinder. Divide $c$–12''' into the same number of equal parts that the circumference has been divided into, and draw vertical lines through the points of division. It will be seen that the intersection of the vertical lines 1 1'', 2 2'', 3 3'', etc., with $a\,b$ are the projections of the points 1, 2, 3, etc., on $a\,b$. Now the lines 1''' 1'''', 2''' 2'''', etc., on the envelope correspond with the vertical lines 1' 1'', 2' 2'', 3' 3'', etc., on the cylinder. Therefore, by drawing horizontal lines 1'' 1'''', 2'' 2'''', etc., the points of intersection 1'''' 2'''' 3'''', etc., will determine the length of the vertical lines or ordinates 1''' 1'''', 2''' 2'''', etc., on the envelope, and by drawing a curve $b$ 1'''' 2''''–12'''' through the extremities of those lines it will represent the form of the envelope.

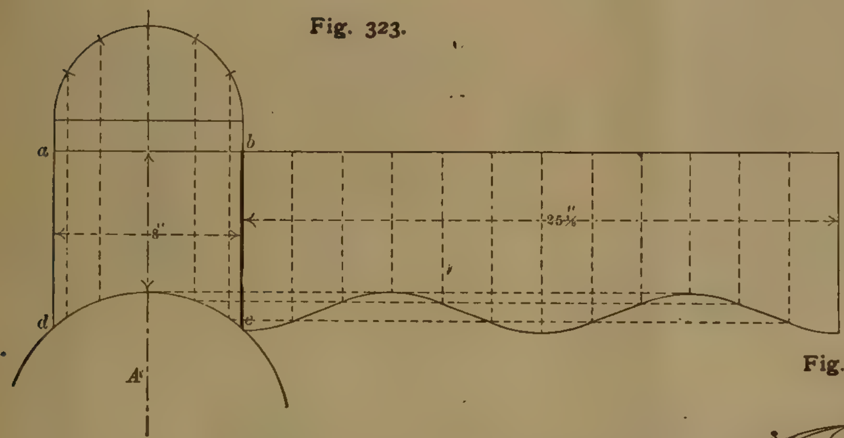


Fig. 323.

PROBLEM 122. *To draw the envelope for a cylinder which penetrates another cylinder.*

Let $a\,b\,c\,d$, fig. 323, represent a cylinder which is attached to or penetrates another cylinder $A$. Draw a plan or half plan of the cylinder $a\,b\,c\,d$ above it, and proceed as in Problem 121. The engraving makes the process sufficiently obvious.

PROBLEM 123. *To draw the envelope for a hemispherical dome c a b, fig. 324, divided into eight equal sections, the joints being in vertical planes.*

First draw a plan, fig. 325, of the dome below fig. 324 and divide its circumference into eight equal parts. Ascertain the circumference of the base, and take one-eighth of it and lay it off at $d\,e$ on $c\,b$ extended. Bisect $d\,e$, and erect a perpendicular $f\,g$ through the point of division. The arc $b\,a\,c$ being a semicircle of a diameter $c\,b$, the arc $a\,b$ is equal to one-quarter the circumference, of which $c\,b$ is the diameter. It will be observed that sections extend from $b\,c$ to the vertex at $a$. Consequently the length of the sections is equal to the arcs $a\,b$ or $a\,c$, which as explained are equal to one-quarter the circumference of the base of the dome. Set off this distance $g\,f$ on the perpendicular in fig. 326 and it will represent the height of the section. Divide each of the arcs $a\,b$ and $a\,c$ into the same number of equal parts $c$ 1, 1 2, 2 3, and 3 $a$—four in this case—and draw horizontal lines 1 1, 2 2, and 3 3 through the points of division. Divide the perpendicular $f\,g$ into the same number of equal parts that $c\,a$ and $b\,a$ have been divided into, and draw horizontal lines

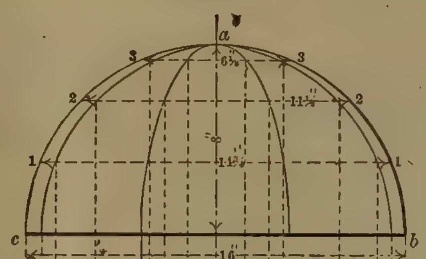


Fig. 324.

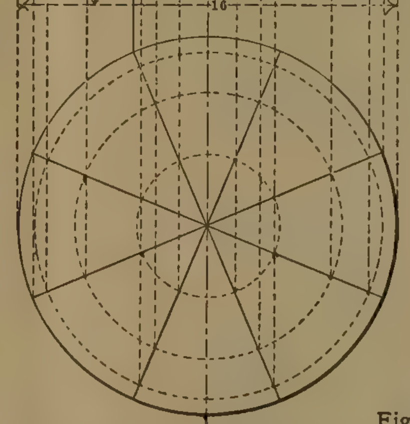


Fig. 325.

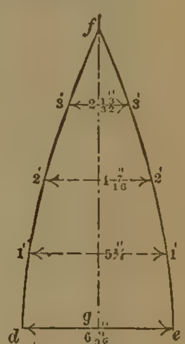


Fig. 326.

1' 1', 2' 2', and 3' 3' through the points of division. Now ascertain the length of the lines 1 1, 2 2, and 3 3, of fig. 324, by measurement, and ascertain the circumferences of which these measurements are the diameters. Take one-sixteenth of the circumference of 1 1 and set it off on each side of the perpendicular $f\,g$ on 1' 1'. Proceed in the same way with the diameter 2 2, and set off one-sixteenth of its circumference from $f\,g$ on 2' 2'.

Fig. 327.

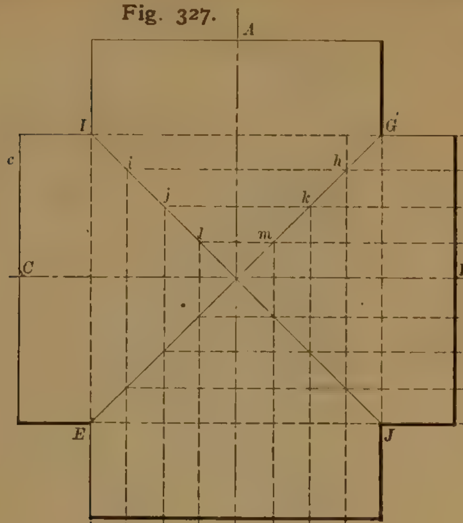
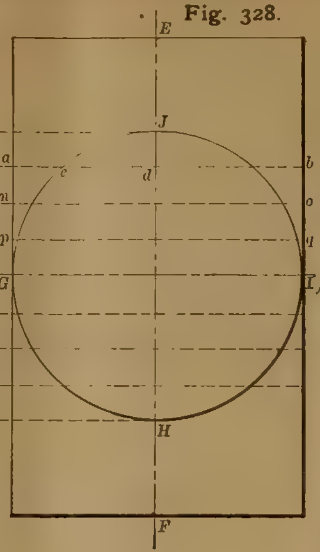



Fig. 328.



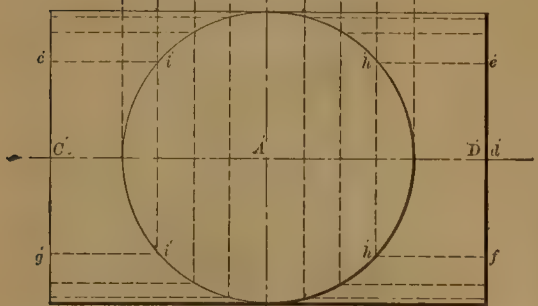




Fig. 329.

Repeat this process with 3 3 and 3′ 3′. Then draw curves *d* 1′ 2′ 3′ *f* and *e* 1 2′ 3′ *f* through the extremities of the horizontal and perpendicular lines in fig. 326. The figure *f e d* will then be that of one of the sections of the cover of the dome.*

## CHAPTER XIV.

### PENETRATIONS OR INTERSECTIONS OF SOLIDS.

On examining the minor details of most machines, we shall find numerous examples of cylindrical and other forms fitted to and even appearing to pass through each other in a great variety of ways. A number of examples have therefore been selected, showing the outlines formed by the penetration of various solid bodies, with a view of exhibiting those cases which are of most frequent occurrence, and elucidating the general principles which are applicable in every case.

### PENETRATIONS OF CYLINDERS.

Problem 123. *To delineate the intersections of two cylinders of equal diameters at right angles to each other.*

Let fig. 327 represent a side view, fig. 328 an end view, and fig. 329 a plan of two such intersecting cylinders *A B* and *C D*. Suppose *a b*, fig. 328, to be a plane cutting the one cylinder, *C D*, parallel, and the other, *A B*, at right angles to its axis. Extend this plane to *c*; then obviously it will pass through the line of intersection of the two cylinders. From the center line *E F*, of fig. 328, take the distance *e d* equal to half of the line *a b* included within the circumference of the circle *G H I J*, and lay it off on each side of *C′ D′*, the horizontal center line of the cylinder *C D* shown in the plan, and draw horizontal lines *e′ c′* and *f g* through the points thus laid down. These lines will represent the intersection of the plane *a b* with the surface of the cylinder *C D*, and consequently the points *h′* and *i′* where the line intersects the circle *A′*, in fig. 329, are the points where the intersecting plane cuts the surface of the cylinder *A B*. By projecting vertical lines from *h′* and *i′* upward to intersect the line *a c*, the points *h* and *i* where they cross each other will be in the line of intersection of the two cylinders. By proceeding in a similar way and drawing other planes, *n o*, *p q*, etc., other points, as *j*, *k*, *l*, *m*, etc., may be determined, and the lines *G E* and *I J* may be drawn through these points and will represent the intersections of the two cylinders. If they are of the same diameter and at right angles to each other, their intersections will be represented by straight lines, as shown in fig. 327, which may be readily drawn through the points *G*, *E*, *I* and *J* where the outlines of the cylinders join each other.

Problem 124. *To delineate the intersections of two cylinders of unequal diameters at right angles to each other.*

Figs. 330, 331, and 332 are side and end views and a plan of two cylinders, of which the one, *A B*, is of smaller diameter than *C D*. The process of

* The student will find that constructing the projection of the junction lines in the covering of the dome, as shown in fig. 324, is an interesting problem. He should be able to work out the method of doing it from the drawing without further explanation.

Fig. 330.

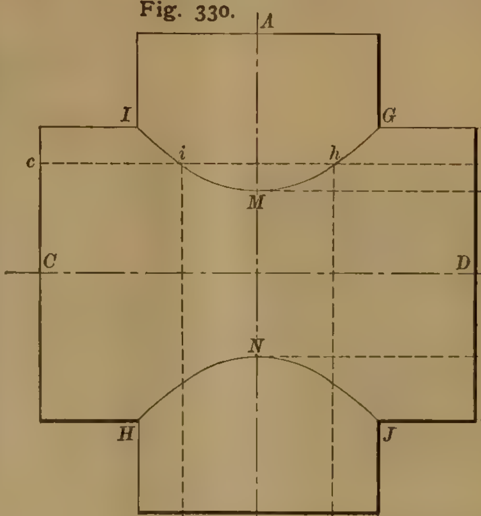
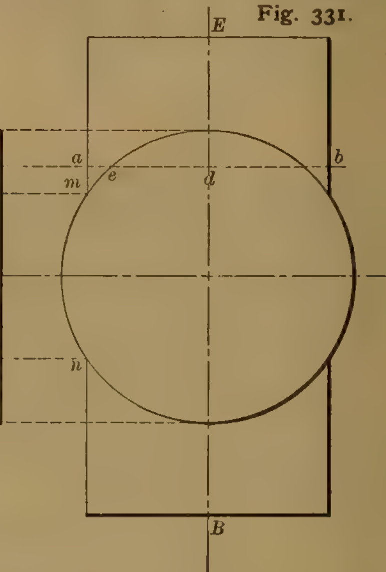



Fig. 331.



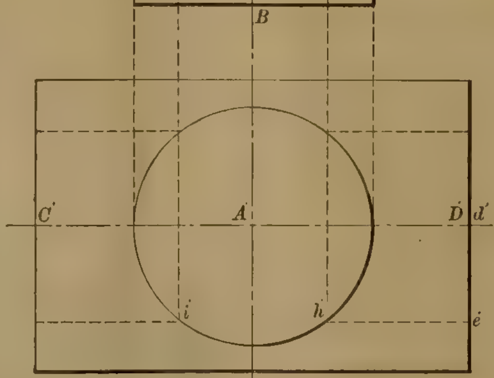




Fig. 332.

delineating the intersections of these two cylinders is the same as that described for those of equal diameters. The lines of intersection $G\ M\ I$ and $J\ N\ H$ when the cylinders are of unequal diameter are hyperbolic curves, as shown in fig. 330. The vertices $M$ and $N$ of the curves are obviously projected directly; and their extreme points are determined by the intersections of the outlines of both cylinders at $m$ and $n$, fig. 331.

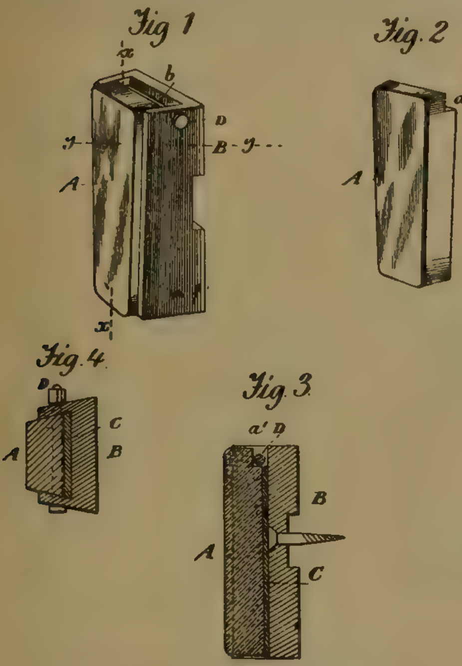
(TO BE CONTINUED.)

## Recent Patents.

### CRISWELL'S BRAKE-SHOE.

A GLASS brake-shoe has been patented by Mr. Peter C. Criswell, of Wheeling, W. Va., the number of the patent being 455,033. This device can best be described in the inventor's own words, as follows: "The special object of this invention is to make brake-shoes so that they will not wear so rapidly as those which have been heretofore used. For this purpose I have experimented and have discovered that a shoe made of glass or faced therewith will greatly outwear those made of any material hitherto used for the purpose.

Fig. 1 of the drawings represents my invention in its holder in perspective; fig. 2, a detail view of a preferred form of shoe; and fig. 3, a section on dotted line $x\ x$ of fig. 1, showing the glass backed by rubber or some elastic material. Fig. 4 is a cross-section of fig. 1 on dotted lines $y\ y$.




CRISWELL'S GLASS BRAKE-SHOE.

"In the drawings, $A$ represents the shoe made of glass, $B$ the holder, and $C$ the rubber or other elastic block between the glass and the holder, which may be made of wood or other material.

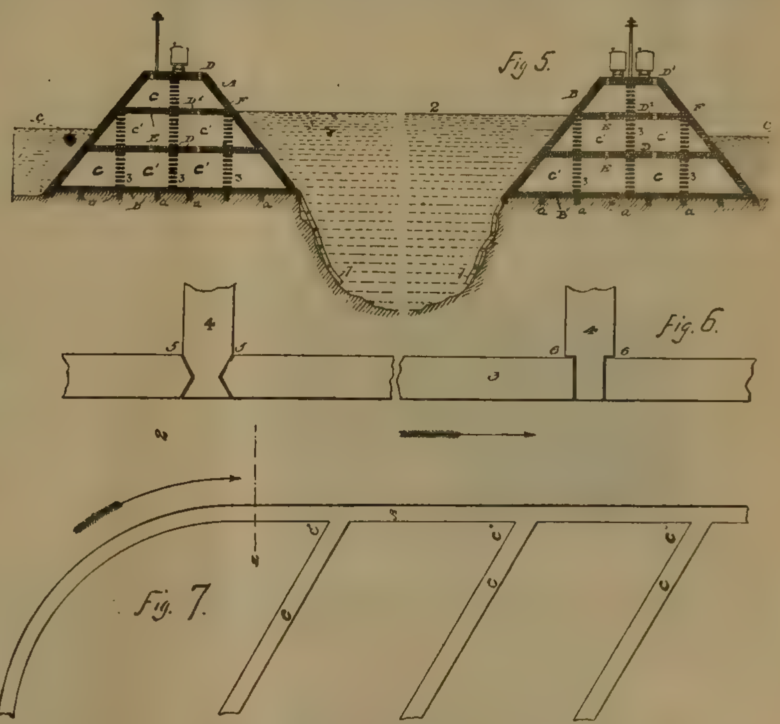
"The shoe is made to taper longitudinally and is beveled on each side, so as to wedge tightly into the holder $B$, which is correspondingly constructed on the interior $b$. The shoe $A$ is also notched at $a'$, and across through this notch and the sides of the holder $B$ passes the screw-bolt $D$, on which fits a suitable nut to hold the bolt securely in position. The shoe $A$ is thus held in a tightly wedged condition all the time.

"The advantages of glass as a material for brake-shoes are that it is much more durable than those which have been heretofore made of wood, metal, asbestos, or compressed paper, as it is not abraded and worn off by friction like other known materials for the purpose; secondly, being moulded to any form or size, it is cheap and easily made to fit any required or preferred holder; thirdly, having no pores or grain, it is not liable to crack or split; fourthly, being a non-combustible substance, it is not injured by the frictional heat, and, fifthly, it does not expand or contract under the influence of heat or moisture. Being solid, without grain, and not porous, it is a harder substance than any of those heretofore used for brake-shoes. Hence it always wears smooth without heating or cutting like metallic brake-shoes, while it will outwear three wooden shoes. Compressed paper and asbestos are soft like wood, and therefore cut, heat, and wear out much more quickly. In view of all these facts, which have been corroborated by practical tests, it seems to be the best substance which can be employed for the purpose."

### KIRK'S RIVER JETTIES.

Figs. 5, 6 and 7 show an improvement in river jetties covered by patent No. 455,216, issued to Arthur Kirk, of Sharpsville, Pa. Fig. 5 is a cross section of a stream with such jetties; fig. 6 is a plan illustrating one of the details described below; fig. 7 is a plan showing the arrangement of the jetties on one side of the river, those on the opposite side corresponding exactly.

In figs. 5 and 7 are shown the course of a stream, 2; $A$ and $B$ are side walls or jetties, which are separated from each other a sufficient space to provide a proper channel between them, and at their upper ends are flared outwardly, so as to catch the water and converge it within the channel. A series of wing dams or walls $c$ project from the outer sides of the jetties $A$ and $B$ toward the shores and slant upstream, say, at about an angle of 45°. These wings on a given side of the jetties are preferably placed at intervals about half or a quarter of a mile apart. The height of the walls $A$ and $B$ is sufficient to collect nearly all the water of the stream during low water, and in high water the wings $c\ c$ will so shoal and retard the flood water that it will deposit its sand, gravel or alluvium behind the wings, and in doing so will fill up the bottom and in time will recover much land which would otherwise be of little value. It will be noticed that the wings $c$ project from the sides of the jetty-walls $A\ B$, which extend upstream from their juncture with the wings, so as to make angles $c''$, which check the current and cause the water to deposit its alluvium. In this point this invention is different from other prior systems, in which, instead of having closed angles on the upper sides of the wings, there are openings at these places through which the water may flow freely, carrying the alluvium with it. As shown in fig. 5, the wings $c$ are made




KIRK'S ARRANGEMENT OF RIVER JETTIES.

to increase gradually in height at an angle of about 30′ or more from the jetty-wall to the shore. The purpose of this is that when the stage of water is high in the river the flow over the jetty-wings and the swiftest current may be toward the middle of the stream at the junction of the wing with the jetty-wall,

while near shore the water, being backed up by the wing, may be slack. This prevents the useless formation of sand-banks in the middle of the stream, and renders the reclaiming of the land much more certain and efficacious.

The construction of the jetty walls is shown in fig. 5. The walls are composed of planks or sawed timber, the bottom floor *B'* resting on mud-sills *a a a*, and the timber frame is built up so as to form chambers *c' c'*, which are filled with sand or other suitable material through holes *E*, made in the flooring *D*. These chambers are built up one over the other until the desired height is reached. It is best to fasten the timbers with wooden pins. A road or railroad may be carried along the top.

To prevent scouring under the wooden walls the banks may be protected by chains 7, in fig. 5, composed of wooden links, which are hung from the bases of the jetty-walls and lie upon the bed of the channel. The links are weighted, so that they may sink to the bottom of the stream. These links are shown in fig. 7 in plan.

# Manufactures.

## A New Copying Process.

A NEW copying process, by which drawings can be copied in their original colors on a white ground, is being introduced by F. W. Devoe & Company, of New York. The special merit of this process is that sectional and other colors can be reproduced exactly, which is sometimes a very convenient matter. The drawing has to be made in special ink, and the copies cost little more than an ordinary blue print.

## The City & South London Electric Road.

THE *Electrical World* of recent date says: "Our cable dispatch this week gives the net results of the first half year's operation of this unique road. It is promising, although not altogether satisfactory. The net profits have been a little over $20,000, an amount only sufficient to pay the interest on the bonds. The total operating expenses per train mile were about 53 cents, which strikes one as being decidedly high; it is certainly high compared with the expectations of the promoters. It will be decidedly interesting to learn whether Mather & Platt, the constructors, are safe in their guarantee of a maximum cost of seven cents per train mile for motive power. Comparisons with American enterprises might be made, but would not be especially instructive on account of totally different conditions. The City & South London Road, as the only underground electric system, is a useful example for the contemplation of those who propose engaging in similar enterprises elsewhere; taken altogether its operation has been very satisfactory, there have been some slight difficulties, but the failures have, as a rule, not been electrical, and could not be fairly charged up to imperfections in the motor system employed. Concerning ventilation, a question that has been much mooted in connection with the proposed underground system in this city, opinions seem to differ very widely. Some of those who have ridden upon the line say that it is eminently agreeable, while others aver that the atmosphere in the tunnel is nothing short of miasmatic. The cars are kept closed for the most part, and consequently are not well ventilated. How much of the allegations against the tunnel are due to the closed cars it is not easy to say. It might be added that information concerning the actual experience obtained in this half year's operation is very difficult to get hold of; for some reason, good or bad, the managers of the road are as mum as oysters as to the details of the work. Nevertheless the road may be classified as fairly successful, and, considering the desperate conservatism of our English cousins, opponents of electric traction can find little consolation in the results of the first six months."

In this connection it may be noted that the West End Company, in Boston, reports the average expense per car mile for motive power on its electric cars in the month of June at 7.31 cents against 10.83 cents for horse cars. The average earnings per mile of the electric cars were 42.71 cents, and for the horse cars 36.85 cents, so that the motive power for the electric cars cost 17.1 per cent. of the gross receipts, while on the horse cars 29.8 per cent. was required.

## An Improved Car Door.

THE accompanying illustrations show a door which, it is claimed, answers the requirements that a freight-car door must be strong, spark-proof, of simple construction, and few parts.

The best malleable iron is used for hangers, wheels, stops, etc., and steel track, made of one piece for any width of door, applied so that no screws or nails can possibly come in contact with the running parts of the door. A complete housing cap is made of metal, with malleabe iron ends riveted together and ready for application.

A new feature is the supply by this company of malleable iron guides and wedges for bottom of door, which, by their construction, offer also a thorough lock when the door is either open or shut, saving all damage by door slatting. Fig. 1 is a side view of the top of this door; fig. 2 a section; fig. 3 shows the bottom rail; fig. 4 is a general view of the door.

Fig. 2.


Fig. 1.

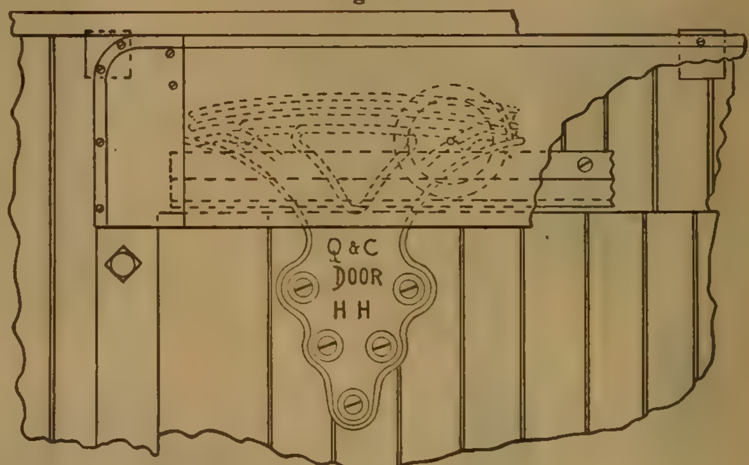



Fig. 3.

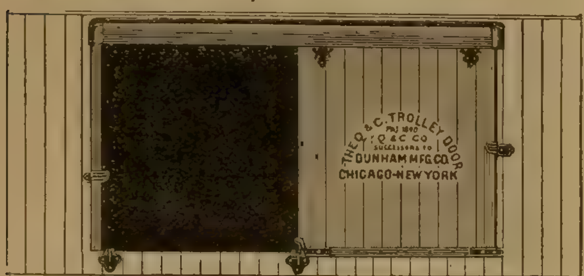
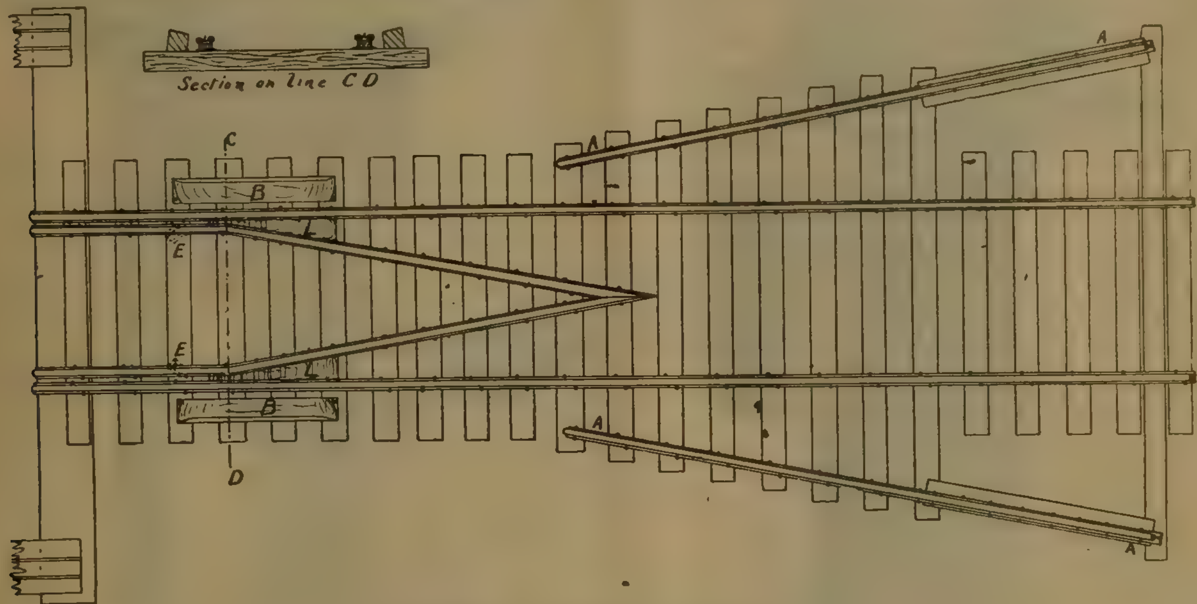



Fig. 4.

## The Tilden Bridge-Guard.

The accompanying sketch shows the bridge-guard made by B. E. Tilden & Company, of Cleveland, O., which has been brought into use on a number of lines. The sketch shows a general plan and a cross-section on the line *C D*. The plan is for a single-track bridge with the inner and outer T guard-rails. The inner guard-rails may end at *E E*, or they may be continued adjacent to the main track rails until they connect with the guard-rails at the other end of the bridge. Bridge-guards *B B* are placed at the side of the rails and opposite to each other, 3 in. from the top of their respective rails and pitching toward them. Lifters *L L* fit into the cavity between the rails, so that the inner guard-rails cannot approach nearer than 2 in. to the top of the track rails. The outer guard-rails *A A* are intended to direct the wheels to the track in case a car is derailed as it approaches the bridge. Should a truck leave the track, its wheels come in contact with a guard-rail, *A*, and are guided to a position close to the rails where the wheels inside of the track are raised by the lifter *L* to a height sufficient to crowd tread of wheels on to the track by adjacent guard-rail, and the wheels outside of the track at the same time pass up the frog and are thus lifted to a height sufficient to allow the flange of the wheel to pass over the rail and the wheels to be drawn on the rails by the guard-rail, the tread of wheels running on the replacers instead of the flange.




TILDEN'S CLEVELAND BRIDGE-GUARD.

The advantages offered by these guards in protecting bridges c n readily be seen by examining the sketch.

## Improved Automatic Square Chisel Car Mortiser and Borer.

The engraving herewith displays a recent improved heavy car mortising and boring machine of the type using square or hollow chisels. It is especially designed for, and capable of cutting the heaviest mortises in hard or soft wood, from $\frac{1}{8}$ in. to 9 in. deep, leaving each mortise entirely free from chips. It will also make end tenons, gain or mortise clear through a 9-in. timber, also countersink for bolt heads. Its high efficiency and adaptability to the work for which it is intended and the great variety of work which can be accomplished with it at one handling of the timber makes it a time and labor-saving machine.

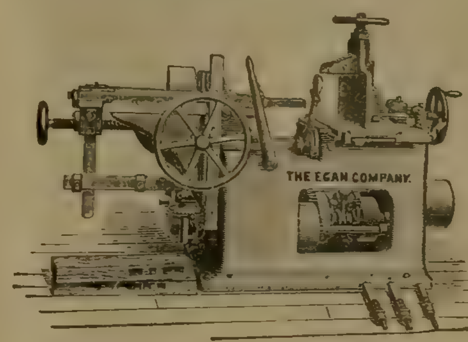
The column is one entire casting cored out at the center, strongly braced and thoroughly able to withstand any strain or shock that may be given it. All working parts are planed perfectly true and in line with each other.

The bed rests on the main column, held in position by gibs, the cross movement being controlled by a friction clutch provided with stops to gauge the length of mortise. The upper part of the bed which holds the timber has an extra movement operated by a hand-wheel and screw to gauge the depth of mortise. All other makes of this style of machine have a stationary bed, and the depth of mortise is made by blocking up behind the timber that is being mortised.

The chisel mandrel is driven by new improved friction gearing, with a quick return, and raised and lowered by rack and pinion. There are suitable stops provided for gauging the travel of the slide, also a regulating screw for changing the position of the chisel to suit the work. The machine will take in stock up to 16 in. wide and 14 in. deep, and cut a gain at the top of a 12-in. timber.

If necessary, an extra boring attachment can be fitted to the machine for boring joint-bolt holes, side sills and general work, and when so made, the builders furnish one auger each $\frac{9}{16}$ in., $\frac{11}{16}$ in., and $\frac{13}{16}$ in. by 10 in. twist, or any other sizes to suit the work.

The builders furnish with the machine four chisels, $\frac{1}{2}$ in., $\frac{3}{4}$ in., 1 in., and $1\frac{1}{2}$ in., with augers to suit. The tight and loose pulleys are 12 in. × $6\frac{1}{2}$ in., and should make 650 revolutions per minute.




IMPROVED CAR MORTISER AND BORER.

For further information in regard to this, address the builders, The Egan Company, Nos. 194–214 West Front Street, Cincinnati, O.

## Wing's Centrifugal Grinding Machines.

These machines, some examples of which are illustrated herewith, represent a radical departure in the construction of grinders for tempered tools. The difficulty with such grinders has been that it has been necessary to run them at low speed, or else to use water to keep them from drawing the temper; and no method tried for applying the water has been altogether successful. In the centrifugal grinders the water is applied to

the stone or wheel at a point near its center, and by capillary attraction is caused to stick to the surface and accumulate in quantity until overcome by centrifugal force imparted by the wheel, then commencing to flow in the direction of the point of its largest diameter, which is entirely encircled by a case which

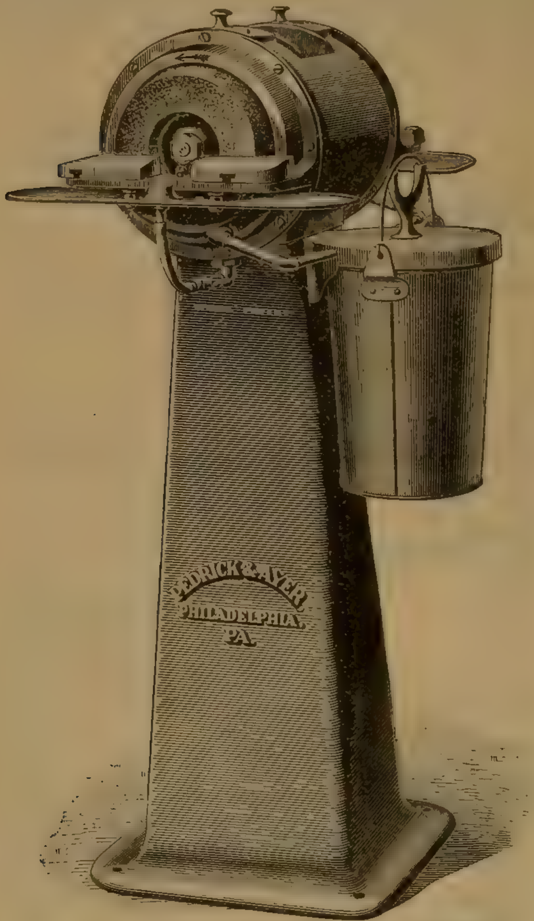



FIG. 1.—NO. 8 HORIZONTAL DOUBLE GRINDER.

catches the water as it flies off, and without the aid of a pump is conducted back to the tank again; the faster the wheel is revolved the more rapidly the water flows, and the ordinary rates of speed and amount of water now used can safely be multiplied several times. And this is not all to be noticed in this connection; the water being made to flow on and over the surface of wheel with force, at right angle to its direction of motion, it is not so apt to fly off when coming in contact with the tool, but is inclined to keep on its natural direction of course; and then the current of water keeps the stone clean and becomes more effectual in keeping the tool cool by being held on the surface at the point of grinding contact.

Fig. 1 shows a No. 8 horizontal double grinder, a machine which is especially adapted to machinists' tool grinding. It carries two grinding wheels 8 in. × 1½ in., one at each end of the arbor. The arbor is of steel, 1 in. in diameter, and runs in removable bronze bushings, which can be easily replaced when worn; these are self-oiling. The water is carried to the wheels from the tank by head force and back into the tank by centrifugal force, keeping up a continuous circulation as long as there is water enough kept in the tank to cover the supply-pipes. This size is also made up to carry a single wheel, and fitted with short legs for bench use, or stand for floor, as preferred, the price being considerably less than for the double-end machine. Larger machines bearing the above description are in preparation and nearly completed.

Fig. 2 shows a No. 12 upright grinder; this machine carries a single wheel, 12 in. in diameter by 2 in. thick, and is mounted on a steel arbor 1½ in. in diameter, running in removable bronze bushings. The grinding face of the wheel is slightly bevelled to accommodate the grinding of long knives which have to lay across the wheel from one side to the other. It is designed for grinding all kinds of wood-working tools having straight edges, like planes, chisels, knives, etc., and is also effective for grinding machinists' and kindred tools, but might be considered by some not quite so convenient as the horizontal machines. The water is brought on to and carried over the surface of wheel and back to tank again by centrifugal force alone, and so continuously as long as water is kept in tank. This machine is as simple in its construction in every respect as the plainest grindstone frame, supplies itself with an abun-

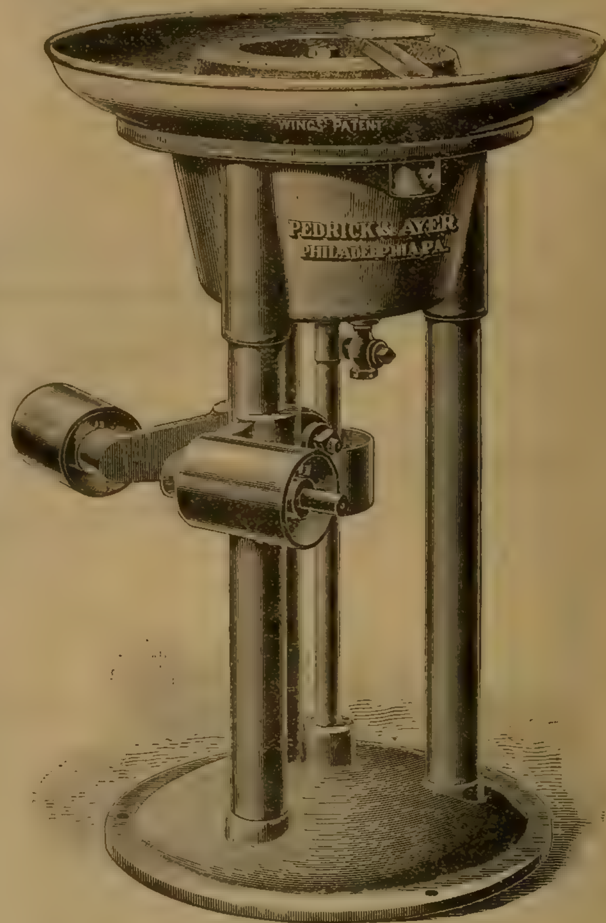



FIG. 2.—NO. 12 UPRIGHT GRINDER.

dant amount of water, is much neater and will do much better and more work.

These machines are made by the well-known firm of Pedrick & Ayer in Philadelphia.

## Electric Lighting by Water Power.

(Condensed from a paper read by Mr. C. T. Ryland, Jr., before the California Electrical Society.)

After giving a short history of electric lighting by water power on the Pacific Coast, Mr. Ryland proceeded to explain some experiments which he had recently made, suggested and made necessary by the fact that so far none of the different manufacturers of water-wheels had succeeded in producing a

Fig. 1.

water-wheel governor sufficiently sensitive and reliable for electrical purposes, especially for incandescent lighting.

Mr. Ryland conceived the idea of dispensing with the governor entirely, and controlling the potential by over compound-

ing the dynamo; requiring a greater speed of the dynamo to maintain the voltage as lights were turned off. In order to construct the dynamos upon this principle it became necessary to obtain a curve of efficiency from some one of the well-known water-wheels in use. The Dodd sigmoidal water-wheel was selected as the best and most efficient for this purpose.

An 18-in. diameter wheel was employed, which is illustrated

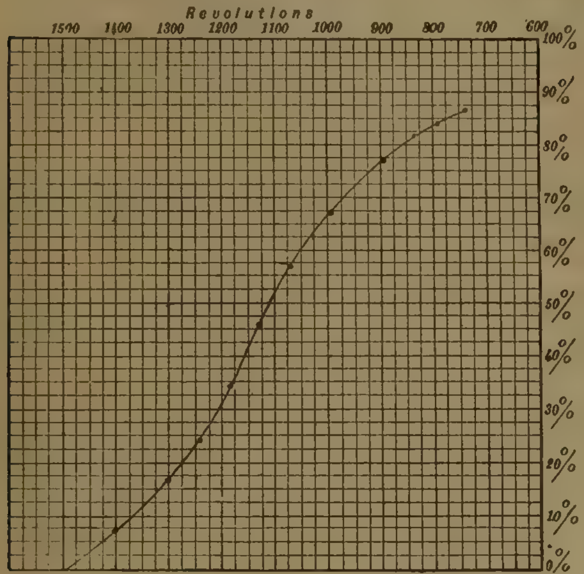



Fig. 2.

herewith in fig. 1, under a head or fall of 213 ft., and the curve of efficiency—fig. 2—was obtained by running the wheel empty and gradually increasing the load from time to time until the maximum was reached.

This curve being obtained and mapped out, the proper number of additional series turns were wound upon the fields of the dynamo, with the following result: At full load the proper voltage was maintained at 750 revolutions per minute of the armature, and when only one lamp was burning the speed was 1,060 revolutions. The effect was that, as the lights were turned off, the wheel ran faster and diminished in power, yet the voltage remained practically constant.

The dynamo used was the Wenstrom, which seemed peculiarly adapted for this kind of work for two reasons: 1. The normal speed is about half that of other dynamos of the same

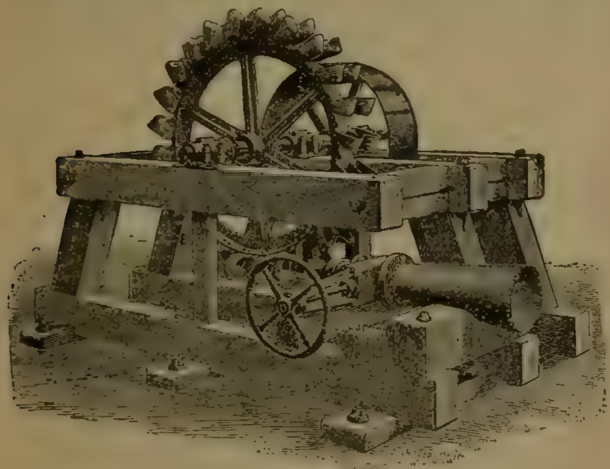


Fig. 3.

capacity. 2. The wires of the armature are threaded through the iron disks, making a practically iron-clad armature; it being impossible for any wires to work loose at any speed of the machine.

Mr. Ryland then described the place where the dynamo was placed, being situated near the bottom of a deep ravine about 300 ft. from the hotel. The water is turned on at 6 o'clock in the evening and turned off at 1 o'clock, without any further attention, and yet lights in the different rooms can be turned on or off without any perceptible change in the brightness of the remaining lights.

The water-wheel employed is perhaps the most recent invention in its class, and possesses points of superiority over other wheels that perhaps may be of interest.

Tangential wheels depend for their high efficiency not only upon the impact of the stream applied, but upon the reactionary effect of the water discharging from the buckets or vanes. None of the wheels heretofore have taken into consideration the effect of centrifugal force (generated under high velocities) acting upon the water when received into the buckets. In the construction of the Dodd wheel this force had been duly considered, with the result that the discharge of the water takes place on each side of the wheel at a point of greater diameter than that of impact, thus utilizing a greater amount of the energy applied than any wheel in its class that we know of. Fig. 3 illustrates the difference in lines of discharge between the Dodd wheel and that of the ordinary tangential wheel.

## A Portable Railroad Drill.

THE illustrations given herewith show a portable drill intended for drilling rails and similar purposes. As will be seen from the engraving, it can also be readily adapted to the use of bridge builders and structural iron workers. By removing the machine from the base and bolting it to the bench it can be used as a bench drill in the shop. In building cable roads or electric

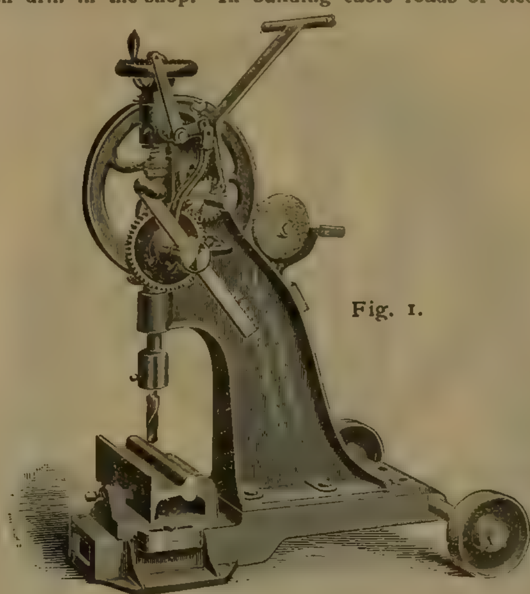


Fig. 1.

PORTABLE RAILROAD DRILL.

roads it is a very useful tool. The makers claim that it will do the work of a ratchet drill in much less time, while it can be more readily applied to the work. The special chuck holding the rail can readily be removed and an ordinary chuck put on in its place.

The machine is provided with an emery wheel for grinding up the drills used—a very useful feature where it has to be used

Fig. 2.

at a distance from the shop. This grinding wheel is geared to make 17 revolutions to one of the crank, and can be brought into use by turning a thumb-screw which brings a friction-wheel in contact with the fly wheel.

The crank is on the same shaft with the balance-wheel, and there is a handle on the balance-wheel, so that two men can work at once. The feed is automatic, with five changes. The machine shown will drill holes up to $1\frac{1}{4}$ in. in diameter and 4 in. deep. As usually made the drill socket takes a $\frac{41}{64}$-in.

straight-shank drill, but other sizes can be furnished, or the socket can be removed and a universal chuck substituted. The machine is strongly made, and will stand heavy work; it weighs complete about 200 lbs., and the base is provided with wheels, as shown, so that it can be easily moved by the operator.

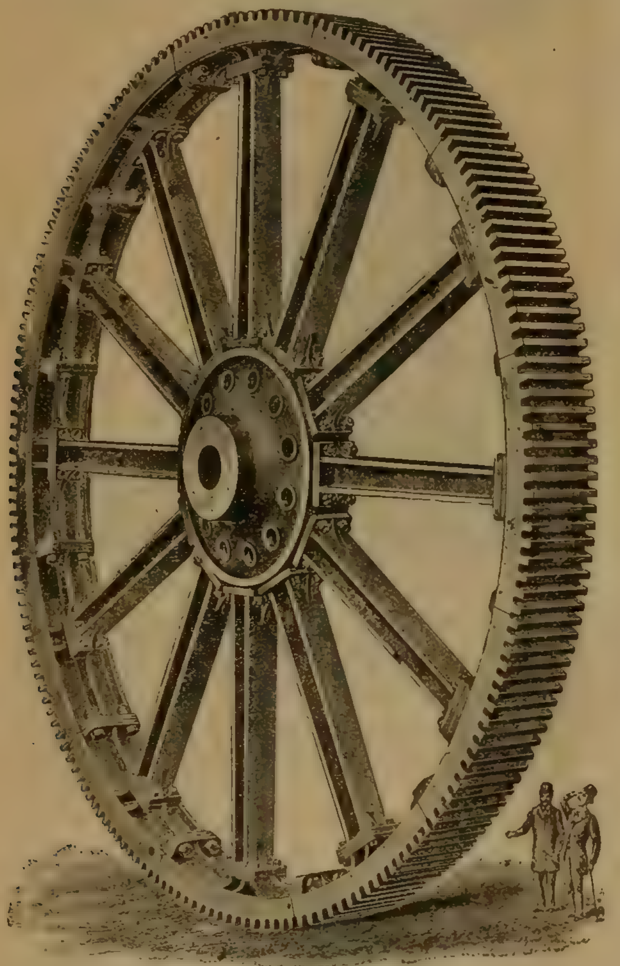
Fig. 1 shows the machine with a rail in position ready to drill; fig. 2 shows how it can be handled to drill work in an inclined position. These machines are made by George Burnham & Company, at Worcester, Mass., who are well known as makers of light drills and other small tools.

## A Large Gear Wheel.

THE accompanying cut shows a very large machine-cut spur-gear recently made by the Walker Manufacturing Company, Cleveland, O. This wheel, with a steel pinion made by the same concern, is used in some large pumping engines for removing water from a diamond mine in South Africa.

The dimensions of the wheel shown are: Number of teeth, 192; diameter to pitch-line, 30 ft. 6.66 in.; face, 30 in.; pitch of teeth, 6 in.; diameter of hub, 9 ft. 2 in.; bore, 27 in. The hub alone weighs 15 tons, and the total weight of the wheel is 66¾ tons.

Some conception of the exactness required in the formation of this large wheel may be realized when known that the owners,



GEAR WHEEL BY WALKER MANUFACTURING COMPANY.

in order to provide for a possible breakage, ordered one segment and one arm additional, the requirements of which were that these parts might fill any position in the wheel. The wheel was fitted up most carefully and was a fine piece of machinery, as may be judged from the illustration.

This gear, with the steel pinion, was the only part of the massive pumping machinery which was made in this country, the balance of work being contracted for in England. In reply to an inquiry as to why the gears had been singled out for manufacture at a different point from the rest of the machinery, the Engineer of the company replied that he thought they could rely on getting a superior class of iron in America, and he knew they could secure as perfect work.

## General Notes.

THE business of the old firm of Riehle Brothers, in Philadelphia, has been divided for greater convenience. The scale business has been transferred to the Riehle Brothers Scale Company, which will continue at the factory, Twenty-third and Filbert streets. The Riehle Brothers Testing Machine Company will continue its office at 413 Market Street, and will conduct the business of manufacturing testing machines, trucks, Robie screw-jacks, and other special machinery; also the iron foundry and general machine business.

THE Wrought Steel Wheel Company has been organized in New Jersey to make steel car wheels. The capital stock is $2,000,000. Mr. William P. Shinn, of Pittsburgh, is President, and General William F. Smith, of Philadelphia, is Treasurer.

AN ingot weighing 32,000 lbs. was recently cast at the steel works of Carnegie, Phipps & Company, at Homestead, Pa. This ingot is to be forged into an armor-plate 80 in. long and 23 in. thick. The casting was made in a sand mould, by a new process, and was very successful.

THE shops of Tippitt & Wood, in Phillipsburg, N. J., are now making the pipe and other iron work for the new plant of the Lehigh Zinc & Iron Company, at Freemansburg, Pa. These shops are also making stand-pipes for the water-works at Lake Forest, Ill., at Defiance, O., and at Portland, Oregon.

IN the works of the Pittsburgh Reduction Company the electrical force used in reducing aluminum is furnished by two Westinghouse dynamos, each driven by a 200-H.P. Westinghouse compound engine, and by two smaller dynamos driven by one 125-H.P. Westinghouse standard engine.

THE Cowles Electric Smelting & Aluminum Company, Lockport, N. Y., announces that aluminum can now be furnished in ton lots at 50 cents per pound. This is considerably lower than any price yet made for this metal.

THE steamer *Corsica* left Ashtabula, O., July 10, ran to Escanaba, there loaded 2,607 tons of iron ore, and returned to Ashtabula, arriving there July 14. The total time of the round trip was 4 days, 2 hours, 50 minutes. Of this 90 hours 14 minutes were consumed in the two voyages, and 8 hours 36 minutes at Escanaba. This is claimed to be the fastest round trip ever made.

THERE is a considerable amount of lighthouse work now going on on the lakes. The Cleveland Shipbuilding Company is building a steel lighthouse tender, and the Globe Iron Works Company, at Cleveland, two others. The Craig Shipbuilding Company, at Toledo, O., has nearly completed three 100-ft. wooden lightships for lake service. The contract for the four steel lightships, Nos. 51, 52, 53 and 54—which were described and illustrated in the JOURNAL for August—has been let to F. W. Wheeler & Company, at West Bay City, Mich. These boats are for service on the Atlantic Coast.

THE Rogers Locomotive Works, Paterson, N. J., are building two switching and eight mogul freight engines for a railroad in Cuba, and 20 locomotives for the Illinois Central Railroad. They are also building six full snow-plows.

THE shops of the Delaware, Lackawanna & Western Railroad at Dover, N. J., are building 100 new box cars. These cars are all to be equipped with the Gould coupler.

THE Pratt & Whitney Company, Hartford, Conn., has recently completed a new brick building 300 × 45 ft. and two stories high, which is to be used for the manufacture of small tools, of which the Company makes a great variety. The building is supplied with a complete plant for their manufacture, and power is supplied by a 75 H.P. engine in the basement.

THE Erie Car Works, Erie, Pa., are to build 300 box cars for the Pittsburgh, Cincinnati, Chicago & St. Louis Railroad.

AT a meeting held in Pittsburgh, July 15, the stockholders of the Westinghouse Electric Company unanimously approved the plan of reorganization proposed, and elected the following new board of directors: Lemuel Bannister, A. M. Byers, George Westinghouse, Jr., Pittsburgh; August Belmont, Charles Fairchild, Marcellus Hartley, George W. Hebard, Henry B. Hyde, Brayton Ives, New York; Charles Francis Adams, Boston. By the plan of reorganization adopted $4,000,000 of 7 per cent. cumulative preferred stock is created, of which $3,000,000 has been taken at par by the reorganization syndicate to care for

the company's floating debt and provide additional capital. The assenting stockholders give up 40 per cent. of their stock, aggregating over $2,500,000, par value, for the use of the company, and are given upon the 60 per cent. of stock which they retain a 7 per cent. preference over the small amount of non-assenting stock remaining out.

THE Taylor Iron & Steel Company, a new organization with $1,000,000 capital stock, has succeeded to the old and well-known Taylor Iron Works at High Bridge, N. J. The officers are: President, Lewis H. Taylor; Vice-President, Robert E. Jennings; General Manager, William T. Taylor; Secretary and Treasurer, T. F. Budlong. The company has acquired the right to make steel and steel castings under the Hadfield patents.

A STEEL car has been patented by Mr. H. C. Hodges, President of the Detroit Lubricator Company, and plans have been prepared for its construction. It is proposed to build a car 68 ft. long, with a capacity of 120,000 lbs. of freight, and the inventor claims that this car will weigh only 40,000 lbs. empty. The advantage of increasing the load and decreasing the number of cars is well known. Mr. Hodges' car is designed to combine the greatest possible strength with simplicity of construction.

THE St. Charles Car Works, St. Charles, Mo., have just completed for the Jacksonville Southeastern line two beautiful chair cars. The body is finished wine color, and has the shield of the road in the center of the coach. The interior decoration of these cars is elegant mahogany finish, and they have a very spacious smoking-room, upholstered in embossed leather. The cars are heated by steam from the engine, and have the Scarritt latest improved twin chairs, which are covered with olive figured plush, to match the finish of the cars.

The Wabash road has lately given an order to the St. Charles Works for six elegant passenger coaches, to be 64 ft. long, to have smoking room and all the latest conveniences that can be put into a coach. They built and delivered to the Wabash last month 250 box cars.

## An Opportunity for Practical Instruction.

THE evening class in Steam Engineering will open at the Young Men's Institute, No. 222 Bowery, New York, on September 30, and will be continued through the winter until April 27. This class is under the charge of Mr. William H. Weightman, who has conducted it very successfully in previous years, and is exceptionally well qualified for the work.

This class offers a good chance for instruction to young men who are anxious to learn and to advance themselves in their business. The total cost of the winter course is between $10 and $11 only, and this includes a year's membership in the Institute, with all its advantages. Further information can be had by application to the Secretary at No. 222 Bowery.

## Baltimore Notes.

THE work of excavating for the Belt Railroad Tunnel has progressed so far from the shafts that it is now necessary to use some kind of power in moving the cars which run on the narrow-gauge construction railroads that are laid in the tunnel, and upon which the earth is hauled out, and the lime, brick, sand, and cement carried up to the headings and side drifts. Steam locomotives will not do, as they give out smoke, and the time is approaching when apparatus will be required for giving fresh air to the miners and workmen. The plant for an air compressor is now being put up at the lot corner of Park Avenue and Preston Street to supply fresh air to all of the shafts. An electric motor has been found impracticable for hauling the cars in the tunnel, as one would be required for every train; so the contractors are now experimenting with a plant that will use the trolley system. In some places the roof is so low that a long, rigid, upright trolley pole will not allow the work trains to run up into the low headings, and a trolley has been devised to work with a double rod, each one having a hinge or knuckle in the center, and it can double up and lie almost flat on top of the car in either direction, when its full-length extension would be obstructed by the earth or over head timbering.

THE Wenstrom Dynamo & Motor Company, located at Calverton, suspended operations temporarily on August 18, throwing about 70 men out of employment, and causing much dissatisfaction, as the men were not paid off. The trouble is said to be due to some difficulty arising between the stockholders and bondholders of the Company, which, it is said, will be amicably adjusted.

IT is reported that the Baltimore & Ohio Southwestern Railroad Company has purchased a large tract of land in Belpre, O., opposite Parkersburg, W. Va., adjoining the cattle-yards and hotel property of the Company, and that a number of switches will be laid, upon which the heavy engines will be run, instead of crossing the river to the West Virginia side, as has been done in the past.

THE Baltimore & Ohio and the Baltimore & Ohio Southwestern are having some very handsome cars built at Pullman, which are intended for a through line to Cincinnati, connecting at Baltimore with the "Royal Blue Line" for New York, making a splendid service through from New York to Cincinnati. The cars, coaches and baggage cars will all be painted the Pullman standard color, and will all be lettered "New York, Washington, Cincinnati & St. Louis;" the cars belonging to the Baltimore & Ohio to have the coat-of-arms of Maryland on the side, and those belonging to the Baltimore & Ohio Southwestern the coat-of-arms of Ohio. The train will probably be called the "B. & O. Southwestern Limited," this marking being placed on the side of the baggage car. These cars will be vestibuled, and will be carpeted and have window curtains, the designs of the interior finish being all fresh and new, and the lighting will be by Pintsch gas.

## Paint.

A LARGE number of tests, made by painters who have no personal interest in the matter, have, it is claimed, proved that Dixon's graphite paint will cover a much larger surface than any other lead or mineral paint. Some 20 years' experience has also proved that on metal work—a tin roof, for instance—it will last from 10 to 15 years before repainting is needed. This is a remarkable durability.

## PERSONALS.

W. B. W. HOWE, JR., has resigned his position as Chief Engineer of the Savannah, Florida & Western Railroad.

STEPHEN LITTLE, formerly connected with the Erie, the Northern Central, and some other roads, is now Controller of the Denver & Rio Grande Company.

D. B. ROBINSON, for some years past General Manager of the Atlantic & Pacific Railroad, is now General Manager of the San Antonio & Aransas Pass Railroad in Texas.

SAMUEL GARWOOD has been chosen Vice-President of the American Steel Wheel Company of Boston. He was recently connected with the Philadelphia & Reading Railroad.

F. H. ROBINSON, recently Assistant Engineer of the Philadelphia, Wilmington & Baltimore Railroad, has been chosen Professor of Civil Engineering in Delaware College at Newark, Del.

J. A. DROEGE has been appointed Superintendent of the Middle Georgia & Atlantic Railroad, with office at Eatonton, Ga. He was recently connected with the East Tennessee, Virginia & Georgia Railroad.

N. O. WHITNEY, for some years past Assistant to the Chief Engineer of the Pennsylvania Company, has resigned that position to become Professor of Railroad Engineering in the University of Wisconsin.

ROBERT H. CAMPBELL has been appointed General Superintendent of the Trans-Ohio Divisions of the Baltimore & Ohio Railroad, with headquarters in Chicago, succeeding EDWARD DICKINSON, who has resigned.

T. J. NICHOLL, recently on the Louisville, New Orleans & Texas, has opened an office as Consulting Engineer at No. 206 Cass Street, Chicago. Mr. Nicholl has had an extensive experience in bridge and railroad work.

SANFORD KEELER has resigned his position as Superintendent of the Flint & Père Marquette Railroad, after 31 years' service on the road in various positions. W. A. POTTER, late Assistant Superintendent, succeeds Mr. Keeler.

C. F. MUSSELMAN, for four years past General Foreman of the shops, has been appointed Master Mechanic and Master Car Builder of the Cincinnati, Portsmouth & Virginia Railroad, with office in Portsmouth, O. He succeeds J. C. HOMER, who resigned to accept service elsewhere.

OCTAVE CHANUTE, President of the American Society of Civil Engineers, is now devoting special attention to the preservation of ties and timber, of which he has made a careful study for some years past. Mr. Chanute is prepared to design or erect works for the treatment of timber, and to conduct tests or experiments in this direction.

## OBITUARY.

JAMES R. OGDEN, who died in Knoxville, Tenn., August 1, aged 54 years, was for many years connected with the East Tennessee, Virginia & Georgia Railroad, and was General Freight Agent of that road for 20 years. He left that road in 1886, and was for a year Vice-Commissioner of the Southern Railroad & Steamship Association. In 1887 he became President of the Knoxville Car-Wheel Works and the Knoxville Iron Company, and continued in that position until his death.

WALTER L. BRAGG, who died at Avon-by-the-Sea, N. J., August 21, aged 53 years, was born in Alabama, and lived in that State or in Arkansas all his life. He served in the Confederate Army during the war. In 1881 he was appointed President of the Alabama Railroad Commission, and held that office till 1887, when he was appointed one of the first members of the Interstate Commerce Commission. He held that position until his death. He was a hard worker, and was a most active and useful member of the Commission.

WILLIAM W. WILSON, who died in Chicago, August 10, aged 59 years, was born in Rochester, N. Y., and served an apprenticeship in the old Erie shops at Dunkirk. After working on various roads he was made General Foreman of the Galena & Chicago Union shops in Chicago in 1859. In 1865 he was appointed Division Master Mechanic on the Chicago, Burlington & Quincy, and in 1875 was made General Master Mechanic of the road. In 1879 he left to become Master Mechanic of the Wabash, and in 1880 was appointed Superintendent of Machinery of the Chicago & Alton Railroad. That position he held until a year ago, when he resigned on account of ill health; he has since been unable to undertake any active work.

JOHN LUTHER RINGWALT, who died in Philadelphia, July 29, had been for 16 years editor of the *Railway World* of that city. He was born in Lancaster, Pa., in 1828, and began work in a newspaper office at an early age. He was connected with several papers, including the Philadelphia *Press*, and in 1875 became editor of the *Railway World*, having previously been an occasional contributor to its predecessor, the *Railroad & Mining Register*. For some time he continued his labors on the *Press*, but during the last 15 years the bulk of his literary labor has appeared in its columns. He had, however, done much incidental writing for other journals, among which may be named the Philadelphia *Inquirer*. Mr. Ringwalt also published two books requiring much labor, the American Encyclopædia of Printing and the Development of Transportation Systems in the United States. He was a hard—almost an incessant—worker, but found time to make many friends, who will most sincerely regret his loss.

JOHN S. GILBERT, who died at Fort Montgomery, N. Y., August 13, aged 90 years, was born in East Haddam, Conn. In his youth he learned the trade of a ship's joiner. While engaged in this work in New York he began to study into the question of improving the methods of getting big ships out on a dock so that repairs might be made more handily. After his work for the day was over he would pass evenings in studying out improvements, and as a result invented finally the balance dry dock. His success in life was from that moment assured, and soon he was engaged in building the dry docks all over the world, and became as well a naval architect. He lived for many years in New York, and there organized the original New York Dry Dock Company, and over 40 years ago built the Erie Basin dry dock. Afterward came an appointment as Naval Constructor at Washington, an office that he held for several years. He built large dry docks at Kittery, Me., and at Charleston, and superintended the construction of that at Mare Island. Abroad he earned the title of Naval Constructor from the Austrian Government, and received various honors from Archduke Maximilian. He retired from business about 30 years ago, with a moderate fortune.

## PROCEEDINGS OF SOCIETIES.

**Engineers' Society of Western Pennsylvania.**—At the regular meeting in Pittsburgh, June 16, Mr. C. Davis reported that the Library Fund was very low, and suggested that those who felt so disposed could or should donate toward this fund to pay for the binding of the unbound volumes now on hand, the donations to be sent to Mr. C. Davis, or to the treasurer.

There being no further business, the paper of the evening was read by Mr. Harry J. Lewis, on Bridge Design. This was generally discussed by members present.

**Technical Society of the Pacific Coast.**—At the regular meeting in San Francisco, July 3, eight new members were admitted.

Two papers were presented: one on Abrasive Processes in the Mechanic Arts, by Mr. J. Richards, and one by Mr. Marsden Mansen, C.E., former President of the Society, on the Physical and Geological Traces of Permanent Cyclone Belts.

These papers had a peculiar interest. The first because it treated on a subject that has scant recognition in technical literature, and the second, because it enters upon a bold hypothesis, supported, however, by much observable data. Both of these papers will be published in an early bulletin of the Society.

AT the regular meeting in San Francisco, August 7, A. J. Brownlie, F. T. Newberry and Emil Neuman were elected members.

Mr. Hubert Vischer read a paper on the use of the figure 9 in arithmetical calculations as an aid to engineers in their computations, and President John Richards delivered an address on Natural Standards, referring particularly to meter, pendulum and contact gauges in mechanical work.

**Master Car & Locomotive Painters' Association.**—The 22d annual convention will be held in Washington, beginning September 9. The Arlington Hotel will be headquarters.

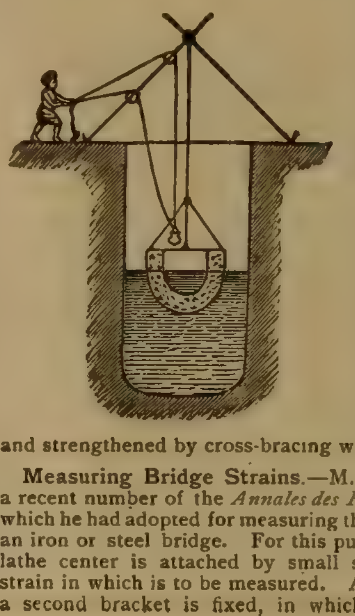
A cordial invitation is extended to all foremen car and locomotive painters throughout the States and Canada, to meet in convention; this being the first meeting at the National Capital, affords an opportunity to visit many places of interest after the close of the session.

**American Association for the Advancement of Science.**—The 40th annual meeting began in Washington, August 19. The meeting was called to order by the retiring President, Professor George L. Goodale, of Harvard University, who introduced the President-elect, Professor Albert B. Prescott, of Michigan University. Addresses of welcome were made by Hon. Edwin Willits, Assistant Secretary of Agriculture, and Dr. J. C. Welling, President of the Columbian University. These addresses were responded to by Dr. Prescott.

An amendment to the constitution was proposed at the last meeting, providing for the election of foreigners as corresponding members of the Association. The amendment was carried by an almost unanimous vote.

## NOTES AND NEWS.

**A Well Water Filter.**—The accompanying sketch, from *Indian Engineering*, shows a cheap and simple filter for wells which was designed by Mr. Henry W. Allen and has been extensively used in the Madras Presidency. The device seems to be a very good one for wells and cisterns of doubtful water which must be used until a better supply can be found.



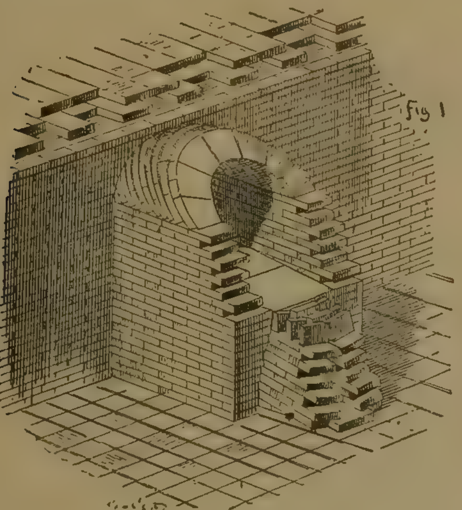
Two baskets are used, with the space between the baskets filled with charcoal, coarse sand and gravel. They are suspended in the well, as per sketch, and the well water, in percolating to the inner basket to replace water as drawn, gets well filtered. The outer basket is made 6 ft. in diameter, and strengthened by cross-bracing with the inner basket.

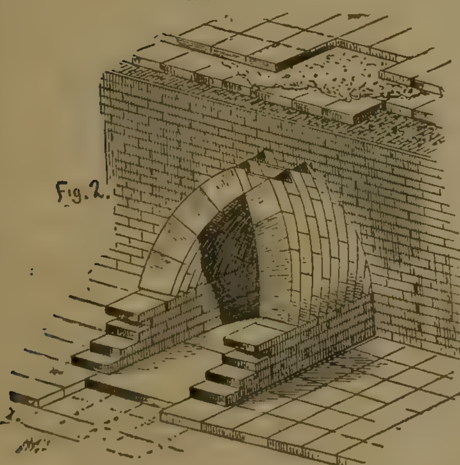
**Measuring Bridge Strains.**—M. Le Chatelier describes in a recent number of the *Annales des Ponts et Chaussées* a method which he had adopted for measuring the strains in the members of an iron or steel bridge. For this purpose a bracket carrying a lathe center is attached by small screws to the member the strain in which is to be measured. At another point of this bar a second bracket is fixed, in which slides a short steel rod

pointed at both ends like a lathe center. Attached to the same bracket is a water chamber closed by a flexible diaphragm of German silver and connected to a fine open tube, in which the water, on being expelled from the chamber, flows and serves to measure on a highly magnified scale any motion of the diaphragm. One end of the double-centered rod presses against this diaphragm, and a bar is supported on the other center point of this rod and on that of the fixed bracket before mentioned. Any extension of the bridge member, therefore, causes a motion of the diaphragm and a fall of the water in the fine tube. Successful measurements are said to have been made on this system when the fixed points between which the extension was taken were only 8 in. apart.

**An Old Method of Building Arches.**—The accompanying cuts, from *le Genie Civil* show a method of building arched conduits used by the Persians in ancient times. The conduits uncovered at Khorsabad have semi-circular (fig. 1) and ogival (fig. 2) sections; a few are also elliptical, but all are built in the manner shown.

The ogival arches are not closed by a key-stone, the opening at the top of the brick courses being filled by clay well rammed down. In building, the mason evidently began his work of arching by forming inclined bases on the side walls, on which the first course of the arch was started. The succeeding courses followed the inclination of the first.




The method was certainly ingenious. It has the advantages of dispensing with the use of arches, and of quickness in execution. Modern masons may take some hints from their old Persian predecessors.

**An Electric Launoh.**—The cut given herewith, from the *Steamship*, shows a pinnace built by Woodhouse & Rawson, of London, in which the screw is worked by an electric motor. The power is furnished by storage batteries carried on the boat. She is named *Electric*, was specially constructed for the conveyance of troops, and is used for that purpose between the

dockyards at Chatham and Sheerness. The craft is 48 ft. 6 in. in length over all by 8 ft. 9 in. beam, with an average draft of 2 ft. 3 in., her full complement being 40 fully equipped soldiers. Her speed averages eight knots per hour, and for cases of emergency she is fitted with two masts, two balance lug sails, and a stay sail, thus enabling her to be sailed or propelled electrically, and to do the same as a steam pinnace of her size. Messrs. Woodhouse & Rawson have a special accumulator which has been under test for several months, and which has given remarkable results; and the employment of this accumulator for launches is expected to lead to considerable extension in the immediate future. It is claimed that the use of electric pinnaces presents considerable advantages over the existing type of steam pinnace, because not only is the electric pinnace always ready for use at a moment's notice, but the carrying capacity for size and accommodation is considerably greater than that of a steam pinnace. The actual cost of propulsion per mile does not exceed that of steam vessels with similar carrying capacity; and one great advantage is that no skilled hands are required for stoking and engineering purposes.

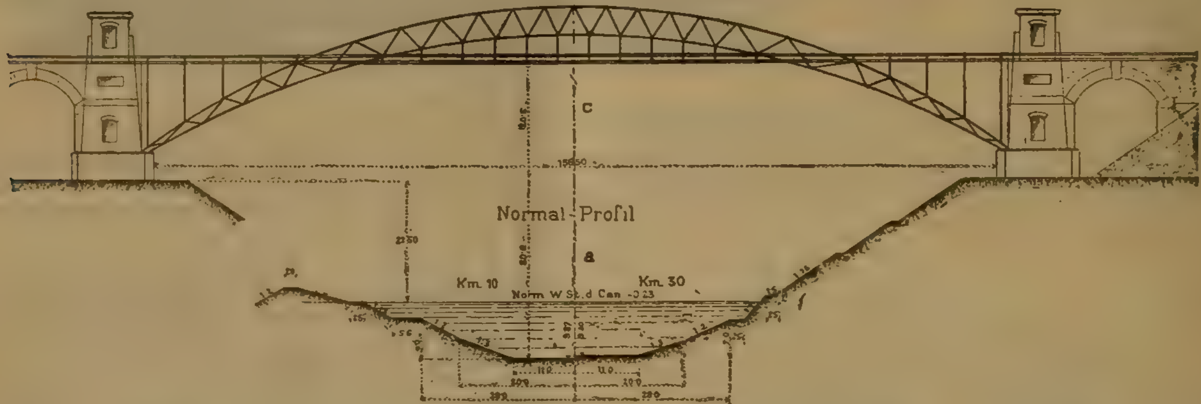
**The Congo Railroad**.—A section of the Congo Railroad from Matadi to the Leopold Ravine, two miles, has been opened, and the first Belgian locomotives are running within sound of the Falls of Yellala, the insurmountable impediment that is met by steamers ascending the lower Congo. Of course there is no passenger traffic yet, but the locomotives and 10-ton trucks are greatly expediting the work of road building, by facilitating the transport of earth, stone, and other material. It is expected next month that 4,000 men will be at work on different points of the line which is to connect Matadi, at the head of navigation on the lower Congo, with Leopoldville on Stanley Pool, 235 miles away. The work, thus far, has progressed satisfactorily, and the engineers anticipate no serious impediments.—*Goldthwaite's Geographical Magazine.*

**A California Mining Plant.**—The Dalmatia Mine and mills are situated far up in the California mountains distant from Placerville, the nearest railroad station, about 15 miles, and nearly 60 miles northeast of Sacramento. The mining camp of Kelsey, where the Dalmatia Mine is located, is 1,500 ft. above the sea. Fuel is dear, and the question of obtaining power for operating the mills is a serious one. The mine is owned by an English syndicate, and is under the management of Mr. G. C. Pearson. After considerable deliberation it was decided to install an electrical power plant. The nearest water is Rock Creek, a stream running down from the mountains into the western fork of the American River. The creek was tapped about two miles above the point where it empties into the river, and the water was then led through ditches dug and blasted along through the rocky soil until a point was reached about 100 ft. above the river and 200 ft. away from it; at the junction close down by the river bank was placed the power station, and the water is led into it through an iron pipe 28 in. in diameter running down the hill-side. At the power house is installed a large Pelton water-wheel that drives a jack-shaft to which is belted a Brush compound wound generator giving 1,800 volts and 40 ampères. The current from this is led through a circuit of No. 3 copper wire over the mountains to the mills one and a half miles distant from the power house. The complete cir-

cuit is therefore a little more than three miles in length. Here the motor equipment is situated and drives the stamps, settlers, and other mining machinery. The plant was installed by Mr. H. S. Connor, the electrician of the Brush Electric Company, and from the very start has given excellent satisfaction. Mr. Pearson, the Manager of the mine, is so thoroughly pleased with the installation, that he is now considering the possibilities of the American River as a source of future power. It is a considerable stream, and an enormous amount of energy is running to waste that might well be utilized in mining operations throughout the surrounding country. Altogether the Dalmatia plant is a capital specimen of the economical and effective way in which electric power can be utilized.—*Electrical World.*

**The Grunthal Bridge.**—The accompanying illustration shows the high bridge over the Baltic-North Sea Ship Canal at Grunthal, which is a notable structure. It has a span of 156.5 meters (513.3 ft.); a clear height of 42 m. (137.8 ft.) above water-level of the canal, and of 51.3 m. (168.3 ft.) above the canal bed.

The bridge shown in this sketch spans the canal near the center of the Grunthal cut, the heaviest work on its whole length.




The lower part of the cut shows the cross-section adopted for the canal; on one side the section in the cutting at the bridge is given, and on the other the section in open country.

At the point where the bridge crosses the bank is 21.5 m. (70.5 ft.) above the water-level, and the depth of the canal is 9.3 m. (30.5 ft.). The cutting is in earth, the soil being light and sandy.

**California Petroleum.**—The present petroleum product on the Pacific Coast is set down as 1,300 barrels daily, of which 40 per cent. is made into a fuel product, used for gas and for fuel. There is but little paraffine in California coal oil; the residue, corresponding to paraffine in Eastern oils, is pitch, or asphaltum, as it is usually called, and is used for varnishing, painting, coating pipes, and in street pavement construction.—*Industry, San Francisco.*

**Aluminium Iron by the Stefanite Process.**—In this process aluminium is introduced into the iron while the latter is in a molten condition, either in the cupola or in the puddling furnace. The separation of the aluminium from its mineral takes place during the operation with the melting of the iron, the new formed metal combining itself at once with the iron. It is known that aluminium in a very small proportion lowers the melting point of iron and steel, and that it makes these metals very fluid in such a way that they can be cast easily and without blow-holes. The adoption of this process has been heretofore prevented by the high price of aluminium, but the great reduction recently made will do away with this objection. The Stefanite process was specially intended to reduce the price of production, and the trials made with it heretofore have been in Germany.

The operation consists in the addition to the iron in the furnace or cupola of emery and alum, either in powder or formed into briquettes. It seems that the reaction of the alum on the emery produces metallic aluminium in the form of a vapor, which at once unites with the iron and gives the latter the special qualities which have heretofore only been obtained by the addition of aluminium to iron or steel in the crucible. The process of casting does not again volatilize the aluminium, which remains combined with the iron. When the addition is made to iron in the puddling furnace the wrought iron produced can be hardened and tempered like steel, and its tensile strength, is considerably increased.—*Revue Scientifique.*

**The Australian Intercolonial Railroad.**—The links of the Intercolonial Railroad chain are not yet complete; and while South Australia is preparing the way for a line to directly tap the rich pastoral districts of Southwestern Queensland, and thus draw their trade to her own northern ports, the people of the Barrier silver fields are earnestly agitating for a railroad to connect Broken Hill with the New South Wales system at Cobar, and thus complete direct rail communication between Adelaide and Sydney. But an infinitely vaster and more important project than any of these is that for the connection of Perth with Port Augusta. The project has for some years past been before the public of both South and West Australia, but in the former colony was shelved as impracticably expensive and probably unremunerative, while in the latter want of means and a certain lack of enterprise, coupled with the uselessness of moving in the matter without South Australia's co-operation, have combined to prevent the taking of active steps for the realization of the scheme. Now, however, we hear that both South and West Australia have been stirred into progressive action; that the former colony is preparing to make a survey of the proposed line to her own border at Eucla, the lone telegraph station on the Great Australian Bight, which is jointly maintained by the two colonies. In West Australia more decisive action has, we are informed, been taken, and its premier, Mr. Forrest, has actually signed a provisional agreement with a syndicate, said to represent a number of British capitalists, for the construction of the line to Eucla.—*Iron.*

**The Japanese Geodetic Survey.**—According to the *Proceedings* of the Royal Geographical Society, the Japanese Government surveys are making excellent progress. A general map of Japan on a scale of 1 : 200,000 was commenced 16 years ago, and is now published (in 77 sheets) for the whole of the islands except Yezo. This is, however, considered merely as a provisional publication, being based on Japanese methods of work, and therefore not to be relied on for accuracy. A modern survey was commenced 11 years ago, with triangulation of four orders, and depending on some five base-lines. Copperplate, photogravure, and lithography are employed in the reproduction of these maps, and few if any Europeans are employed. The work appears to be excellent. Only a small proportion is completed, and it will be many years before the whole is finished. About 300 of the published sheets can now be bought: the scale is 1 : 20,000. A map on a scale of 1 : 100,000 is also being prepared, based on the 1 : 20,000 map, but no sheets are yet for sale. The names on these maps are in Japanese characters. In the Geological Survey of Japan reconnoissance map, Roman characters are used, and 1 : 400,000 is the scale.

**Snow in Fortification.**—Experiments were recently made in Russia to determine the resisting power of snow walls against artillery. Two walls of snow were built up and fired against at a distance of 600 yards by field artillery. The balls penetrated a distance of 18 ft. into the walls.

The Russians have also been recently trying infantry firing at snow walls. The men of the Eighty-first Infantry Regiment, under the superintendence of General Count Boref, built a wall about 50 ft. long, 18 ft. thick, and 4½ ft. high. Behind the walls were placed, at equal intervals, four targets, at each of which four volleys were fired, at distances of 800, 400, 200, and 100 paces.

The penetrating powers of the volleys were: At 100 paces, 9 ft; at 200 paces, 5 ft. 7 in.; at 400 paces, 4 ft. 7 in.; at 800 paces, 4 ft. Experiments made in our own Army, however, seem to show that the resisting power of snow is less than indicated by these experiments. When compressed, however, its resistance is very much increased.

THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

THE OLDEST RAILROAD PAPER IN THE WORLD.

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NEW YORK, OCTOBER, 1891.

THE car-builders generally seem to be looking forward to a busy season, and several large contracts have already been announced. The heavy crops in the West will make a demand for an increased number of freight cars, while the roads leading to Chicago are already making preparations for the great increase of traffic which they expect from the Exposition in that city, so that passenger and freight car business both are benefited.

SUBSTANTIAL progress is now being made with the buildings of the Columbian Exposition at Chicago. Not very much has been done toward the proper representation of railroads there, and some hard work will have to be done within the next year to secure it.

THE fighting ships of the Navy, as distinguished from the cruisers, are making slow but steady progress toward completion. The engines of the armored cruiser *Maine* are now ready for the vessel, and her completion next year is a possibility if the armor plates are furnished in time. Work on the engines of the *Texas* has been slightly delayed, but the vessel itself is making excellent progress at Norfolk. She will probably not be launched until next spring, but much of the work which has been done on the *Maine* since her launch will be done on the *Texas* in the yard, so that no time will be lost. The armored cruiser *New York*, at the Cramp yards in Philadelphia, is so far advanced that she will be launched before the close of the year, and she will be ready for service at about the same time as the *Maine*.

THE navigation of the air has heretofore been hardly considered a practical question by most men, chiefly from the reason that those who have attempted it have generally been persons without sufficient theoretical or practical knowledge to meet the conditions involved. It has now been undertaken, however, by another class of men, who are thoroughly equipped for dealing with the problems involved, and experiments conducted by such high authorities as Professor Langley, of the Smithsonian Institution, and Mr. Chanute, President of the American Society of Civil Engineers, promise some valuable results. Professor Langley is especially firm in the belief that the time is not far distant when some practicable device for traveling through the air will be secured, and he is doing his best to aid in such a result.

In another column we give the first part of an account of the Progress of Aerial Navigation, by Mr. Chanute; in these papers he will describe the theoretical conditions involved, give a historical account of the attempts which have heretofore been made, and a description of the experiments now in progress.

THE New York Central & Hudson River Company is making arrangements to replace the signals at present in use between the Grand Central Station and Mott Haven by an entirely new system, which will be supplied by the Johnson Signal Company, and will be as complete as possible. The need of such a change has been apparent for some time, the present one being insufficient. It is true that there are a large number of trains to be handled there, as the traffic of the Hudson River and Harlem Divisions and of the New Haven road is concentrated upon the five miles between the Grand Central and Harlem Bridge; but the company has the advantage of four tracks, except for the very short distance across the bridge, and there are practically no freight trains to interfere with the passenger business. With a better signal system it is probable that the delays, of which there is now much complaint, will be done away with, leaving only those which are unavoidable at present, at least so long as the Harlem drawbridge remains.

THE Baltimore & Ohio Company is making considerable expenditures on the improvement of its terminal facilities. New yards are being provided for the better handling and distribution of freight, and an expensive belt or connecting road is under construction through Baltimore. When these are completed the road will be better placed than ever before to dispose of a large freight business. From the returns made public, it appears that these new facilities are needed, for the traffic of the road has shown a large and steady gain for several months past.

SOME reference has heretofore been made to the terminal improvements which the Pennsylvania Railroad is making in Jersey City. The new passenger station there and the elevated line through the city are now approaching completion, and the company will soon have the best passenger station in or about New York. It is somewhat singular that the largest city in the country has been notable heretofore for the shabbiness and inadequate size of its railroad stations, but something has really been done at last to remove that reproach. The Erie, the New Jersey Central, and the Pennsylvania now have stations which are fairly well fitted for their business, and of sufficient size, though not much can be said of their architectural beauty; and if the New York Central can hardly say the same, it is because the business of the Grand Central Station has increased more rapidly than enlargements could be made to provide for its accommodation.

THE instances cited above might be increased in number, but they are sufficient to indicate that the heaviest railroad expenditures of the present year have been made not in building new railroads, but in terminal improve-

ments and facilities for handling business on existing roads. The growth of cities and towns has been so rapid during the last 10 or 15 years that improvements have been forced on the railroads and the cities alike. In many cases these have been deferred too long, so that the increased value of property has made them more costly and difficult of execution than they would have been if undertaken sooner; but this is a trouble that always has existed, and probably always will exist as long as man's "hindsight is better than his foresight," as they say in New England.

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ANOTHER new line to the Pacific will before long be completed by the Great Northern Company, the successor to the St. Paul, Minneapolis & Manitoba. This line will depend for its prosperity on the growth of the new States along the northern frontier, and for through business will be a formidable competitor of both the Northern Pacific and the Canadian Pacific.

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THE death of Mr. John H. B. Latrobe, of Baltimore, removes one of the very few remaining men whose personal experience reached back to the beginning of railroads in this country. Mr. Latrobe had been connected with the Baltimore & Ohio Railroad in various capacities all through his active life; he was the son of the great engineer whose genius may almost be said to have created that road, and he was the last survivor of those who accompanied Peter Cooper on the trial trip of his little locomotive, on the success of which so many future possibilities depended. We of the present generation find it hard to realize how small and apparently insignificant was the commencement of our railroads; but Mr. Latrobe had seen it all with his own eyes, and had taken an active and useful part in the small beginning and the later growth.

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THE Interstate Commerce Commission has suffered a serious loss in the retirement of its head, Judge Cooley, and the recent death of Mr. Bragg. Judge Cooley commanded general respect from his knowledge of the law, his ability and the judicial temper of his mind; he came to the Commission with a high reputation from his service on the bench, and has given his knowledge and experience to the difficult questions which have arisen under the law. Commissioner Bragg had had previous experience on a State commission, and was one of the most active, faithful, and hard-working members of the Board. It will be no easy matter to fill the vacancies properly, and it is to be hoped that considerations of fitness alone will govern the President in selecting the new commissioners.

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THE breaking up of the Squadron of Evolution has begun by the detaching of several of the vessels composing it for service in various stations. The squadron has apparently served its purpose, and the new ships will probably be sent off one by one. Their services are urgently needed to replace the older ships, which are now nearly worn out, and must give place to their modern successors.

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THE Canadian Pacific has accomplished a notable feat in landing the Japanese mails in London within 20 days of the time of their starting from Yokohama. This was done by fast passages across both the Pacific and Atlantic oceans, and a quick rail trip from Vancouver to New York. Heretofore no attempt at speed has been made by the steamers crossing the Pacific; but the new competition may bring their standard up nearer to that of the Atlantic lines than it has been.

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WITH this record, which our own lines will doubtless try to cut down, and with the Great Siberian Railroad actually in progress, giving promise of a through line from St. Petersburg to Vladivostok in a few years, the time may not be far distant when a man may start from New York for a little trip around the world with a reasonable expectation of reaching his home again within the month.

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FAST time is reported on land as well as by water, and recently a train on the Philadelphia & Reading Railroad, in a run, the particulars of which are given elsewhere with those of another fast run on the New York Central, made a mile in 39.8 seconds, or at the rate of 90.45 miles an hour. This, it is claimed, is the fastest railroad time ever made.

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STATE ownership and State construction of railroads are not made more attractive by the corruption lately brought to public notice by the parliamentary investigation in Canada. Our own methods of railroad building have their defects, but at least they do not involve the grave public scandals which, we fear, could not be avoided where great and expensive public works are carried on by a government conducted by political parties, and largely through politicians, as ours must be. Canada is learning a hard lesson, which ought to serve as a warning to other countries.

## UNIFORM REPORTS OF LOCOMOTIVE PERFORMANCE.

ONE of the subjects which has been selected for consideration by a committee of the Master Mechanics' Association, and to be reported on next year, is the one which forms the title of this article. Any one interested in the performance of locomotives, who takes the trouble to study the reports made by different railroad companies, will find that they differ so widely from each other that it is difficult to make any comparisons which are conclusive with reference to the relative performance on different roads. There is no common agreement regarding the data which are reported, and in many cases essential facts are omitted altogether. As heretofore stated in these pages, some companies issue reports printed on the backs of postal-cards in which only the most meager data are given. Other companies, as the Illinois Central, issue reports on a number of sheets which are 35 × 19 in. in size, on which the most minute statistics are given with reference to each engine on the line.

A student of the subject will soon find that the reports of some roads are almost useless, by reason of important omissions, whereas those of other lines are confusing on account of the great mass of figures, from which it is difficult to draw any deductions. In this, as in all other fields of human endeavor, it is important to discriminate between those things which are essential and effective in accomplishing the end aimed at and those which serve no useful purpose. A study of any considerable number of these performance sheets, as they are called, will reveal to the student many defects and omissions, and their ambiguity is in many cases very vexatious.

A little consideration of the object of making such reports will indicate the data which they should contain. Their chief purpose undoubtedly is to enable comparisons to be made of the performance of locomotives on the same or on different roads, and thus to ascertain their relative efficiency and economy.

Thus the "chief end" of a locomotive—to quote the Catechism—is to haul trains, and the more hauling it does the better it fulfills its "final cause." That is, the more miles it runs and, in many cases, the more cars it pulls, the better it fulfills its purpose, and the greater its value or efficiency. In other words, a locomotive which will run on an average 3,000 miles per month is worth more to a railroad company than one which will run only 2,000, and for some kinds of traffic a machine which will pull 30 freight cars is much more useful than one which will pull only 20. Therefore to compare what may be called the *serviceability* of locomotives on the same line, or on different lines, or in different countries we should know how many miles they run, per day, per month or per year. There should be no ambiguity about this mileage—that is, it should be definitely known whether the mileage is counted only by the distance between terminals, or whether any extra allowance is made for running the distance from the engine-house to the station, or *vice versâ;* for switching or for any other reason. There should be no difference in the method of keeping the mileage on different lines, and the committee appointed to report on this subject should recommend some definite method of keeping the mileage of different classes of trains, and of switching and construction engines, etc.

A good deal of difference prevails, too, in the matter of the division of this mileage. Only a portion of the reports which are published give the number of the engines owned by the companies. In some cases the total mileage is divided by the number of engines which are in a serviceable condition—that is, which are not undergoing repairs. In others all the engines owned are included. For purposes of comparison it seems desirable that each company should report the total number of locomotives owned which are not condemned or leased to other lines, and also the average number in the shop undergoing repairs or held in reserve. This will make it possible to give the average mileage of all engines owned—which is the safest basis of comparison—and also the average mileage of those in service. Obviously it is a merit of the management of the mechanical department to keep the engines in such a condition as to get the maximum mileage out of them, and the fewer there are in the shop the greater the mileage that can be made. If an account was kept of every day that each engine is in the shop, and at the end of the month the aggregate number of days was divided by 30, it would give the average number undergoing repairs during the month, or at the end of the year. By dividing by 365 it would give the average for the year. Probably such figures as these would be a revelation to many general managers if compared with similar data from other roads.

It may at any rate be confidently said that all locomotive reports should give the mileage of locomotives based upon some common method of making it up, and also the number of engines owned by the company which are not condemned.

For the same, and also for another reason, the train loads should be reported. It hardly needs to be said that in some kinds of traffic the larger the loads hauled the greater the useful service performed. Besides this reason, it is impossible to make any comparisons of fuel consumption which can be relied on without knowing the loads hauled. In many of the reports before us no account whatever is kept of the train loads. On other lines the average number of cars in all trains is given, and on still others the average number of passenger and freight cars is reported separately.

The ordinary postal-card report gives the total number of miles run by all locomotives. This makes any comparison between the service of passenger or freight engines impossible. Many roads, however, now report separately the total mileage of passenger, freight, switching and construction engines. If in the enumeration of the engines owned they would divide them into the number employed in each of their different classes of service, it would enable comparisons to be made of the service performed by the locomotives in each of these kinds of traffic. The report of the Pennsylvania lines west of Pittsburgh gives the miles run by freight engines, "loaded" and "empty," and also the average and the maximum mileage of engines in each class of service. This is admirable for purposes of comparison.

The expenses of locomotive service are usually divided into cost of fuel, oil, waste, repairs, wages of engineers and firemen, cleaning and attendance, fuel and water stations. Some considerable differences exist in the method of dividing these accounts. The fuel consumption is reported most frequently by the average number of miles run to a ton of coal. In the Erie Railroad report the number of pounds of coal used per mile in passenger, ballast, switching and freight service, and also the amount consumed per passenger and per freight car per mile, is reported. This is the most satisfactory form of report with reference to fuel consumption that we know of, especially as the average number of cars per train for both passenger and freight trains is also reported. To report the number of pounds of coal consumed per mile seems very much more satisfactory than to give the number of miles run per ton, as the latter always involves the doubt whether a ton of 2,000 or 2,240 lbs. is meant.

In giving car mileage two empty freight cars are usually rated as one loaded, but on some lines three empties are rated as two loaded ones, and on the Missouri Pacific five empties are assumed to be equal to three loads. It is desirable, of course, that there should be some uniform practice in this respect, although it is possible that, owing to peculiarities of traffic, one rating might be nearer correct on one road than another rating would be somewhere else.

In regard to reporting the consumption of waste, lubricating oil, tallow and illuminating oil a great diversity of practice prevails. In some reports it is all included under the general head of "stores." In others waste, lubricating and illuminating oils are reported separately. In the report of the St. Louis & San Francisco Railroad the consumption of engine, valve, illuminating and lubricating oils and waste are each given separately. It seems as though it would be sufficient to report lubricating and illuminating oils and waste separately, giving the number of miles run to a pint of oil and a pound of waste.

The cost of repairs is very generally reported as so much per mile run, although on some of the Pennsylvania lines it is given as so much per 100 miles run. It is not

always clear, however, what is included under the heading of repairs. The whole cost of building new engines to replace old ones on some roads is charged to repairs. On others only that part of the cost which equals the original value of the engine replaced is charged to repairs. Some uniform practice is very desirable, which the committee having the subject under consideration should recommend.

The wages of engineers and firemen are very generally charged at so much per mile run, although in some cases the cost of cleaning and attendance is included. A better plan seems to be to keep these expenses separate.

In reporting the cost of locomotive service the price at which fuel is charged is usually given, although some curious ambiguities are practised, such as charging coal at some nominal price quite different from its actual cost. The total cost of locomotive service is in some cases carried out and given at so much per mile run. In some reports the cost per car mile is also given. All such data would be very much more satisfactory if the cost for different classes of traffic, such as passenger, freight, switching, and construction, was given separately, per engine and per car mile. This would make comparisons and analyses of accounts possible, which without such division cannot be made.

It seems very certain that if locomotive reports gave more complete data concerning the cost of motive power service, that they would indicate where economy is possible, whereas with the reports as made at present managers of roads are now in great darkness.

## A CORRECTION.

In the September JOURNAL, page 426, there was published an article on Electric Lighting by Water Power, condensed from a paper read by C. T. Ryland, Jr., before the California Electrical Society. This was accompanied by illustrations of the Dodd sigmoidal water-wheel (figs. 1 and 3) and by a cut (fig. 2) purporting to show the curve of efficiency obtained from a wheel of that pattern running an electric light plant at the Geyser Hotel, in Sonoma County, Cal.

Information of a reliable character has since been furnished to us to the effect that no such test was ever made on the Dodd wheel. A test was made, but it was on a Pelton wheel, which was then running the electric light station at the Geysers, where the experiments were conducted. The efficiency curve was, in fact, that of the Pelton wheel.

We make this correction as a matter of justice to the Pelton Water Wheel Company, whose wheel is entitled to all the credit for high efficiency in the test.

The paper in question was sent to us as coming from a responsible source and having been read before a reputable public association. The condensation was made by Mr. Ryland, and there was no apparent reason to doubt the statements made. It now appears that there was an imposition practised in changing the name of the wheel, which is not at all creditable to those who may be responsible.

In this connection it may be noted that there is at present much interest felt in methods of utilizing water powers heretofore neglected. This will be increased by the remarkable results recently obtained in Germany in the transmission of power long distances by electricity.

## NEW PUBLICATIONS.

REPORT OF THE PROCEEDINGS OF THE 24TH ANNUAL CONVENTION OF THE AMERICAN RAILROAD MASTER MECHANICS' ASSOCIATION. *Held at Cape May, N. J., June* 6, 7, *and* 8, 1891. Edited by Angus Sinclair, Secretary. The Association, New York.

This report makes its appearance in good season this year, and shows signs of careful editing in its general arrangement and in the complete index appended to it. As the convention was one of average interest, with no special features, the report follows the same course. The discussions on Air Brake Standards and on Compound Locomotives will perhaps receive the most attention. As usual, the report is published in very neat style.

HANDY LIST OF BOOKS ON MINES AND MINING. *A Reference Catalogue.* Compiled by H. E. Haferkorn. H. E. Haferkorn, Milwaukee, Wis.

This is Part IV. of Mr. Haferkorn's "Handy Lists" of technical literature. Like the preceding numbers, it is intended to give as complete a list as possible of all books in the special department to which it refers. Its preparation must have required a great amount of work, and it will be of much service to students, engineers and others interested.

NATIONAL CAR AND LOCOMOTIVE BUILDER SUPPLEMENT. *August*, 1891. John N. Reynolds, New York.

This *Supplement* makes its yearly appearance as usual, but is larger than ever before, the present number having 124 pages in all. It contains much useful information, having lists of locomotive builders, car builders, car wheel, axle and spring makers, rail mills and others useful for reference. There are also lists of street railroads and their officers, and of the railroads of South America, with their officers.

The number of advertisements in the *Supplement* is so great that it may almost be considered a directory of manufacturers of railroad supplies. It is increased this year by many street-car builders and manufacturers of electrical appliances.

A SHORT MANUAL OF ANALYTICAL CHEMISTRY, QUALITATIVE AND QUANTITATIVE—INORGANIC AND ORGANIC. By John Muter. *First American from the Fourth English Edition.* Edited by Dr. Claude C. Hamilton. P. Blakiston, Son & Company, Philadelphia.

Mr. Muter's reputation as an analytical chemist would lead to the acceptance of his book as high authority. It is, of course, strictly technical in its nature, and is intended as a book of reference and for advanced students; those whose knowledge of chemistry is elementary would find it very difficult reading. The writer's aim has evidently been to condense the information as much as possible, and to give the student an account of the latest and most approved methods of analysis in a small space.

The editor of the American edition has made some changes in classification and arrangement, and has introduced the name of each chemical formula, where that formula appears in the book for the first time. Some additions have been made also, and the changes are generally improvements.

ANNUAL REPORT OF THE CHIEF OF THE BUREAU OF STEAM ENGINEERING, NAVY DEPARTMENT, FOR THE YEAR 1890. Engineer-in-Chief George W. Melville, Chief of Bureau. Washington; Government Printing Office.

Like the report for the preceding year, this report covers a period of hard work. During the year the Bureau was called upon to design machinery for battle-ships 1, 2 and 3; armored cruiser No. 2; protected cruiser No. 5; cruiser No. 12, and

the Ammen ram, all large and important ships. This work had to be done in addition to supervising work on the vessels already begun, the repairs and routine work at the navy yards and a large amount of experimental and testing work, especially in connection with tubulous boilers. These represent a large amount of hard work.

Engineer-in-Chief Melville again calls attention to a matter which is just now troubling nearly all the navies of the world, the insufficiency of the engineer force. The traditions of the naval force have been almost everywhere, it seems, strong enough to prevent the increase of the engineer force in number and rank in proportion to the increase of its real importance, and until this is overcome the trouble will continue.

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SAFE BUILDING. *A Treatise Giving Practical and Theoretical Rules and Formulæ used in the Construction of Buildings.* By Louis de Coppet Berg. Ticknor & Company, Boston; price, $5.

Perhaps a better title for this book would be "Architectural Engineering," for it is really a manual of engineering as applied to the construction of buildings of all classes. The author's object has been to teach, so far as can be done by books, the knowledge necessary to erect buildings which shall be safe, and sufficiently strong for the purposes for which they are to be used.

The various chapters include Strength of Materials; Foundations; Cellar and Retaining Walls; Walls and Piers; Arches; Floor Beams and Girders; Graphical Analysis of Transverse Strains. There are a number of tables giving strength of beams, strength of materials, etc., and a large number of formulas. As a general rule, the diagram, the formula on which the table is based and the table are brought as close together as possible—a much better practice than the common one of placing the tables by themselves at the end of the book. The formulas generally are worked out so that they can be followed and understood by any one whose knowledge of mathematics extends to arithmetic, algebra and plane geometry.

Mr. Berg has evidently tried to condense the matter in hand as much as possible, and to use no more space in explanation than was absolutely required. Considering the extent of the subject this was necessary, perhaps, but in some places it has been carried almost too far, and a little more extended explanation might have been of service. It is a book which requires careful study and not merely reading.

As a manual of the engineering of architecture it must be extremely useful to architects; it is an excellent manual and book of reference for the engineer also, especially the railroad engineer, who is so often called upon to design and construct buildings. He will here find the general rules, with which he is of course familiar, reduced to practise and specially applied to the case of buildings in a way which is very convenient, and will probably save him much time and work. There are, of course, many things which are found in other treatises, but the special applications are new and put in a form where they are at hand and ready for use in any case which may be under consideration.

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ANCIENT AND MODERN LIGHT-HOUSES. By Major D. P. Heap, Corps of Engineers, United States Army. Ticknor & Company, Boston; price, $5.

Light-houses are a sign of civilization, and can hardly be expected to exist until a nation advances far enough to have a commerce of considerable importance. They have existed since very ancient times, however, as is known by undoubted testimony, although very little is known of their construction. In the Mediterranean there were some famous structures, such as the great Pharos of Alexandria, but nothing now remains of them. In modern times, as commerce has extended, the number of light-houses has very greatly increased, and now they are found all over the world.

There are numerous classes of light-houses and beacons. Shore lights are not generally difficult of construction; but there are many on exposed rocks and shoals where the very best skill of the architect and the engineer has been required to plan structures which can resist the force of the ocean, and to devise means for building them. How difficult such work may sometimes be is shown by the fact that the light-house on Minot's Ledge, off the Massachusetts coast, was under construction five years; in one year—1857—only 130 hours' work could be done, so uncertain was the sea, while a single storm in two days almost entirely destroyed two years' work. The loss of the great caisson prepared for the foundation of the Diamond Shoal Light, off Cape Hatteras, is a recent instance of the dangers and uncertainties of such work.

Major Heap, who has had a long experience as an engineer in light-house work, has made a very interesting volume of 220 pages, in which he describes generally the different classes of light-houses and their design, and then gives accounts of a number of noted buildings, such as the Eddystone, the Bell Rock and the Skerryvore lights in English waters; the Minot's Ledge, the Spectacle Rock, the Tillamook, the Rothersand and others on our own coasts. Full descriptions of these typical structures are given, with accounts of the methods followed in building them and the ways in which the difficulties met were overcome. Apart from their general interest these are worth study, if only to see the resources at the command of an engineer who has to meet and control the ocean before he can complete his work.

Besides a number of smaller engravings in the text, the book has 32 large plates, which are admirably executed; indeed, it is quite refreshing to read a book where so little fault can be found with the illustrations.

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THE YEAR'S NAVAL PROGRESS: ANNUAL OF THE OFFICE OF NAVAL INTELLIGENCE, JULY, 1891. *General Information Series. No. X: Information from Abroad.* Prepared by the Office of Naval Intelligence, Navy Department. Government Printing Office, Washington.

The present volume of the Annual of the Office of Naval Intelligence retains the title of last year's issue, and, like that number, is not devoted to any special subject, but rather to a general review of the naval progress of the year in various countries. The topics included in it cover a wide range, as will be seen by the titles of the various chapters, which are: I. Notes on Ships and Torpedo Boats; II. Notes on Machinery; III. Notes on Ordnance; IV. Electricity on Shipboard; V. The Naval Manœuvers of 1890; VI. The Armor Question in 1891; VII. The Coast Defense Systems of Europe; VIII. Service High Explosives; IX. The Torpedo Vessel: a History of its Development; X. The System of Promotion in European Navies; XI. Some Standard Books on Professional Subjects.

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EXPERIMENTS IN AERODYNAMICS. By S. P. Langley. *Smithsonian Contributions to Knowledge.* Smithsonian Institution, Washington, D. C.

This is, perhaps, the most important single publication which has ever been printed on the subject of aerial navigation. It proves facts that have long been suspected by students of the subject, and explodes theories that have been the pets of some scientific men for many years. Professor Langley not only shows that mechanical flight is possible, but that it is possible by the use of mechanical means already in our possession and with many of which we are familiar.

Flight by the use of buoyant gas bags or by vibrating wings is entirely omitted in the discussion, and no experiments have been made on such apparatus; but they have been entirely confined to aerial propelling screws and to rectangular planes moved through the air under various conditions of velocity, angle of impact, and superposition, Professor Langley evi-

dently believing that if flight is accomplished by man, it will be after the manner in which soaring birds navigate the air on wings which are apparently motionless.

To prove the truth of this impression, a whirling table 60 ft. in diameter was constructed at the Allegheny City Observatory, Allegheny City, Pa., about four years ago, and numerous experiments were made whenever the weather permitted. At the edge of the whirling table were placed the screws and planes which were experimented upon.

The planes were always rectangular, and were forced through the air sometimes with the long edge, sometimes with the short edge in advance. They were sometimes horizontal, sometimes inclined with the forward edge highest, and the uplift and the resistance to forward motion, due to the pressure of the air on the under side of the plane, were automatically registered by devices of great delicacy and accuracy.

One of the most important conclusions from these experiments is that the inertia of the air plays a very effective part in the flight of birds—much more effective than is usually supposed. If a horizontal plane in rapid horizontal translation be allowed to fall through the air, its time of fall will be much greater than if it fell vertically; and this retardation, due to the horizontal translation, is so marked that Professor Langley concludes that any formula which would correctly indicate it would also show that if the plane were given an infinite horizontal velocity, its time of fall would also be infinite. The reason for this phenomenon is that the air, having inertia, requires time to be put in motion and leave the path of the plane. This leads up to the very important principle which nature observes in the construction of the best flying animals—viz., that the rectangular dimensions of the supporting surfaces should differ as widely as may be, and that the direction of motion should be in the direction of the least dimension. Thus the long-winged sailing birds act upon a greater mass of air in the same time than those which have short wings, and there is therefore less air put in motion under the wing, there is less "slip," and there is less power required.

The point upon which Professor Langley lays the greatest stress, and which he evidently believes to be the most important one indicated in the Memoir, is that the power required for horizontal flight will decrease when the velocity increases, the weight remaining the same. This statement is so insufficiently qualified as to be quite misleading to those who have given the subject of aerial navigation but little or no attention. Professor Langley, throughout the whole Memoir, has ignored the resistance which the air will oppose to the motion through it of the body of any aerial craft, and of the edges of those portions which form the supporting surfaces. It was well for him to do so; but it would have been much better had he frequently and explicitly so stated, especially in connection with the conclusion referred to, and which he considers important enough to repeat several times and to italicize.

The casual, or even the fairly close reader would certainly infer from Professor Langley's Memoir that that gentleman desired to convey the impression that the limit of possible speed was entirely indeterminate, and that perhaps 400 or 500 miles an hour might be expected, while as a matter of fact a few calculations show that under the most favorable circumstances the limit will be reached at perhaps a quarter of that speed. Although the power required to overcome gravity will undoubtedly decrease somewhat when the velocity increases, the power required to overcome the resistance of the air on other than the supporting surfaces will increase as the cube of the velocity, weight being unchanged.

The apparatus used in the experiments was evidently designed with great ingenuity and constructed with great care. The author has not attempted to deduce formulæ, but has indicated some conclusions which may be drawn from the experiments, and most of the mathematical work is correctly done.

The preface states that most of the financial means for conducting the experiments were furnished by the late William Thaw, of Pittsburgh, and the Memoir has been referred to a commission of which Professors Simon Newcomb, Henry A. Rowland, and Cleveland Abbé are members.

## TRADE CATALOGUES.

*Catalogue E, Presses, Dies, etc.; made by the Ferracute Machine Company, Bridgeton, N. J.*

The extent to which press and die work has been carried by manufacturers is shown by the fact that this company makes regularly and carries in its catalogues 150 different kinds of presses, this including only the regular styles, and not special presses made to order. The present catalogue includes only a part of these, other catalogues being published by the company; but it covers a wide range, from light foot presses weighing only 250 lbs., up to power presses weighing 9,000 lbs. and intended for the heaviest class of work. The Ferracute Company probably has a greater variety of work to do in this line than any other establishment, and its catalogues are worth consulting.

*Goulds' Triplex Power Pumps for Mill Service. The Goulds Manufacturing Company, Seneca Falls, N. Y.*

*Goulds' Triplex Electrical Pumps. The Goulds Manufacturing Company, Seneca Falls, N. Y.*

The object of the first of these pamphlets is to show the advantages obtained by the use of the Goulds triplex pump in mills, for filling tanks, for boiler feeding, for paper machines, and in other places where a smooth-running, steady and reliable pump is needed. The applications are fully illustrated by diagrams, and the pamphlet is so neatly printed and mounted as to make it very attractive to the eye.

The second is intended to describe and illustrate the use of the pump with an electric motor, which may be applied in many places where it is not convenient to use a steam-pump or steam-engine. This catalogue is illustrated and printed very handsomely also.

*What We Manufacture. The Cincinnati Corrugating Company, Piqua, O.*

*How to Make Money out of Inventions; an Adviser for Patentees: by August Schemmel. The C. A. Rohde Company, Milwaukee, Wis.*

## BOOKS RECEIVED.

*A Treatise on Wooden Trestle Bridges, According to the Present Practice on American Railroads.* By Wolcott C. Foster. New York; John Wiley & Sons. This book is received too late for review in the present number.

*Poor's Directory of Railway Officials and Manual of American Street Railroads:* 1891. New York; H. V. & H. W. Poor.

*Selected Papers of the Institution of Civil Engineers.* London, England; published by the Institution. The present installment includes several important papers.

*Progressive Examinations of Locomotive Engineers and Firemen.* By John A. Hill. New York; published by the Author; price, 50 cents.

*Reports of the Consuls of the United States to the Department of State: No. 129, June,* 1891. Washington; Government Printing Office.

*The Statistical Year-Book of Canada for* 1890. Compiled by Sydney D. Roper. Ottawa, Canada ; published by the Department of Agriculture. Sixth year of issue.

*The Mechanical Errors in the Common Theory of Flexure.* By R. H. Cousins, C.E. Houston, Texas. ; published by the Author.

*Transactions of the Liverpool Engineering Society : Volume XII. Seventeenth Session.* Edited by J. H. T. Turner, Honorary Secretary. Liverpool, England ; published by the Society.

*Annali della Societa degli Ingegneri e degli Architetti Italiani,* 1891. *Part III.* Rome, Italy ; published by the Society.

*Cornell University, Agricultural Experiment Station : Bulletins* 29, *July,* 1891, *and* 30, *August,* 1891. Ithaca, N. Y. ; published by the University.

## TECHNICAL SCHOOLS.

THE University of Wisconsin at Madison has made important changes in its Technical Department, which are perhaps best explained by the following extract from its announcement :

There have been added three entirely new chairs : a professorship of Railroad Engineering, a professorship of Electrical Engineering and a professorship of Machine Design, and to these there have been called men of exceptional training and ability. Besides these additions, the work of the existing chairs has been modified and developed so as to give a better division of labor and superior efficiency. The professorship of Mechanical Engineering becomes centralized upon steam engineering as its leading subject. The theoretical and scientific treatment of electricity and magnetism heretofore falling under the professorship of Physics has been developed into a professorship of Electricity and Magnetism in connection with mathematical physics, and will have for its functions the fundamental scientific treatment of those subjects, while the practical side will be treated by an experienced expert under the professorship of electrical engineering. A professorship of Bridge and Hydraulic engineering has been developed from the chair of Civil Engineering and the latter title dropped, because, in the progress of engineering science, it has become too broad and indefinite. The assistant professorship of Pure and Applied Mechanics has been advanced into a full professorship with the slightly modified title of Theoretical and Applied Mechanics. The chair of Mechanical Practice undergoes no change except an enlargement of facilities. An instructorship in Engineering has been added.

The Pratt Institute in Brooklyn, N. Y., has made many improvements in its Scientific Department in the way of more extended courses, and in its Trade Schools in increasing the range of instruction and the facilities for practical work.

Purdue University at Lafayette, Ind., has completed a new engineering laboratory, a building 50 × 110 ft., with a boiler-room 25 × 40 ft. In these buildings are a Babcock & Wilcox boiler ; a Harris-Corliss triple-expansion engine, and a Schenectady locomotive, the latter mounted so as to allow its performances to be tested. There are also steam pumps, testing machines, and apparatus for hydraulic work in considerable variety.

## ABOUT BOOKS AND PERIODICALS.

THE article in SCRIBNER'S MAGAZINE for October on the New Lake in the Desert, by Major J. W. Powell, is written by one who speaks with authority from his intimate knowledge of the natural conditions. The number contains several other readable papers, and is fully up to the standard of this well-known magazine.

Among the articles in the POPULAR SCIENCE MONTHLY for October are Mr. Durfee's on the Manufacture of Steel ; Professor Dolbear's on Metamorphoses in Education ; Professor Patrick's on the Rivalry of the Higher Senses, and Mr. Carroll D. Wright's on Lessons from the Census. The last named is the first of a series which cannot fail to be valuable.

In HARPER'S WEEKLY for September 9 there is a very interesting illustrated article on the Alaskan Boundary Survey. The same number has a full-page cut of the new Grand Central Station in Chicago, and an account of the work done by the Columbian Exhibition Commissioners abroad.

In the ARENA for September there are several notable articles, perhaps the most striking being on Inter-Migration, by Dr. Schindler ; on the Austrian Postal Bank System, by Sylvester Baxter ; on Constitutional Government in Japan, by Kuma Oishi, and on Un-American Tendencies, by Dr. Martyn.

Mr. Montgomery Schuyler's Glimpses of American Architecture close in HARPER'S MAGAZINE for October with his impressions of characteristic buildings in St. Paul and Minneapolis. Other articles are on Cairo, on Plantagenet London, on the Art Students' League of New York, and a number of lighter articles, making excellent reading.

The COMPASS for September has articles describing a new slope-stake setter and universal slope indicator, designed by Mr. William Coxe. Other articles are on Verniers Proportionally Divided, the Plain Transit, and on Speedy Calculators. The continuation of the article on Series of Numbers, which was begun in the first number of this paper, contains some useful hints as to practical application.

The September number of the JOURNAL of the New England Water-Works Association contains the report of the proceedings of the tenth annual convention, which was held at Hartford in June. In this report there are several interesting discussions besides all the papers which were presented at the Convention.

The latest number of the PROCEEDINGS of the Engineers' Club of Philadelphia gives the annual address of President Spangler. Among the papers in this number are Rail Joints, by G. W. Creighton ; Continuous Rails, by R. T. Gleaves ; Lobnitz System of Moving Rocks under Water, by E. S. Crawley, and a very interesting illustrated paper on Topographical Surveying, by Harvey Linton.

The SCHOOL OF MINES QUARTERLY for July has an article on Brick Pavements, by Werner Boecklin, and one on Graphic Field Notes, by Bailey Willis. The rest of the number is chiefly devoted to articles from the chemical and metallurgical sections of the school.

In the OVERLAND MONTHLY for September are articles on Trout Fishing in California, on Pitcairn's Island, and on some Pioneer Experiences, besides a variety of excellent sketches and stories.

The JOURNAL of the American Society of Naval Engineers for August has articles on the Orvis System for Steam Boilers, by Chief Engineer Isherwood ; on Indicator Tests, by Assistant Engineer F. H. Conant ; the Servé Ribbed Boiler Tube, by Passed Assistant Engineer G. Willits, and a number of others of interest. Nearly all the articles are illustrated.

The JOURNAL of the Military Service Institution for September continues General Tidball's paper on Artillery in the Rebellion. Other articles are on Field Exercises, by Major Babcock ; on the Northern Volunteers, by Colonel Livermore ; Military Service Reform, by Colonel Anderson, and the Organization of Artillery Defense, by Captain Chester. There is also the usual variety of translations and items of interest to military readers, many of them being also interesting to civilians.

A new paper which has lately made its appearance is RAILWAY LAW AND LEGISLATION, which is published in Washington under the conduct of W. P. Cannaday and G. B. West. Its

object is expressed in its title, and it may be made a very useful journal under proper management.

The announcement has been made of the consolidation of the Chicago RAILWAY AGE and the NORTHWESTERN RAILROADER, heretofore published at St. Paul. Mr. Harry P. Robinson, of the *Northwestern Railroader*, will be at the head of the new concern, and Mr. H. R. Hobart, who has been connected with the *Age* from its first beginning, will remain as Editor. We hope that the consolidated paper will combine the many excellent features which have heretofore marked both papers, and we cordially wish our old-new contemporary the prosperity which it deserves.

The latest number of the PROCEEDINGS of the United States Naval Institute contains four long and elaborate papers, the first being on Explosives and Ordnance Material, by Mr. S. H. Emmens; the second on the Stability of Unarmored Ships and the Effect of Water-Line Damage, by Charles Hemje; the third, the most purely technical of the number, is on the Naval Reserve and Naval Militia, by Lieutenant J. C. Soley, while the fourth is on the Final Improvements of the Steam Engines, by Professor Thurston.

In OUTING for September there is a variety of travel and sport sufficient to suit all readers. The number has some excellent illustrations. The military article for the month is on the Massachusetts Volunteer Militia, and concludes the account of the military establishment of that State.

## SOME CURRENT NOTES.

A NEW line between New York and Boston has been opened by the Long Island and the New York & New England Companies. The train runs from Brooklyn to Oyster Bay over the Long Island Railroad, and is then ferried across the Sound on the transfer steamer *Cape Charles* to Wilson's Point. From there to Hawleyville the route is over the Danbury & Norwalk Railroad, and from Hawleyville to Boston over the New York & New England. The time made at present is about eight hours, and only one train is run—a night train composed of sleeping cars.

THE Grand Trunk Tunnel under the St. Clair River, between Detroit and Port Huron, of which a description has already been given, was formerly opened for traffic September 19. The trains are run through the tunnel by special engines built for the service; they are of sufficient size to handle trains over the heavy grades in the approaches, and burn coke in order to avoid smoke.

THE traffic through the Sault Ste. Marie Canal in August was larger than ever before in the history of the canal for one month. The total number of vessels passed through was 1,720, of which 1,229 were steamers, 434 sailing vessels, and 57 rafts and unregistered boats. These vessels carried through 1,545,607 tons of freight and 8,099 passengers. It is evident that the lake ship-owners are trying to make the best of what remains of the season of navigation.

THE long-distance transmission plant which has been built in connection with the Electrical Exhibition at Frankfort, in Germany, was completed early in September and put into operation. This plant was, to a certain extent, experimental, as its builders undertook to transmit power by electricity over a much greater distance than had heretofore been attempted. The power is derived from the waterfall at Lauffen, in Switzerland, and the plant is intended to transmit 300 H.P. from that place to Frankfort, a distance of 120 miles. A special pole line was built for the purpose, part of it being in the rough mountain country, where many difficulties were met with in completing the line. The latest news from Frankfort is that power is now being transmitted regularly without difficulty, and that the dynamos at Lauffen are operating 1,000 electric lights in Frankfort very successfully. Experiments with this important line are to be continued for some time, and should they prove completely successful, the field for the utilization of power and transmission by electricity will be greatly widened.

THE Philadelphia & Reading Company now claims that the best railroad time on record has been made on its road. The run was made August 27, and was an experimental one, made to see how great a speed could be attained. The train was drawn by Engine No. 206, which has 20 × 24-in. cylinders, 68-in. drivers, and a Wootten boiler. The train consisted of two ordinary passenger cars and the President's special car, and the run was on the Bound Brook Division. Time was taken on 12 miles, from Noble to Langhorne, the total distance being run in 8 minutes 42.2 seconds. The time for each mile is given as follows:

| Miles. | Seconds. | Miles. | Seconds. | Miles. | Seconds. |
|---|---|---|---|---|---|
| 1. | 45.0 | 5. | 46.2 | 9. | 40.0 |
| 2. | 42.6 | 6. | 42.6 | 10. | 39.8 |
| 3. | 44.6 | 7. | 42.4 | 11. | 47.8 |
| 4. | 47.2 | 8. | 42.0 | 12. | 42.0 |

The train, therefore, ran the 12 miles at an average speed of a mile in 43.5 seconds, or at the rate of 82.53 miles an hour, while the best mile was made at the rate of 90.45 miles an hour.

WHILE the quickest short run on record is apparently noted above, a New York Central & Hudson River train has made the quickest long distance run. Like the other, it was an experimental run, made for the purpose of deciding what time could be made by a through train between New York and Buffalo. The train consisted of two drawing-room cars and General Superintendent Voorhees' private car; the total weight of the three being 259,600 lbs. The engine which drew the train from New York to Albany was No. 870, a Schenectady engine having 19 × 24-in. cylinders and 78-in. drivers; the boiler is 58 in. in diameter and the fire-box 96 × 40⅞ in. The engine weighed, at starting, 60 tons and the tender 40 tons, making the total weight of the train 230 tons. From Albany to Syracuse the train was drawn by Engine No. 876, and from Syracuse to Buffalo by No. 862, both of these locomotives being the same as No. 870, except that their driving-wheels are 69 in. instead of 78 in. in diameter.

The total time for the 436½ miles from New York to East Buffalo, without deducting stops, was 439¾ minutes—7 hours, 19¾ minutes. The train left the Grand Central Station in New York at 7:30 15 A.M., and reached East Buffalo at 2:50 P.M. From East Buffalo to the Buffalo station 8¼ minutes were required.

The run of 436½ miles was thus made at an average speed of 59.53 miles an hour, without allowance for stops. Three stops were made in all—at Albany, to change engines, 3 minutes 28 seconds; at Syracuse, to change engines, 2 minutes 30 seconds; at Fairport, to cool a hot box, 7 minutes 50 seconds. The total time lost was thus 13:48 minutes, leaving the actual running time 426 minutes. The time over the three divisions of the road, deducting stops, was as follows:

| | Miles. | Minutes. | Av. speed miles per hour. |
|---|---|---|---|
| New York—Albany | 143 | 140 | 61.29 |
| Albany—Syracuse | 147⅓ | 146 | 60.55 |
| Syracuse—E. Buffalo | 146 | 140 | 62.57 |
| Total | 436⅓ | 426 | 61.88 |

The total time consumed from station to station, 440 miles, without making allowance for the stops or for the comparatively slow time from East Buffalo to Buffalo station, was 448 minutes—an average of 58.93 miles an hour.

It is understood that an approach to this extraordinary time is to be put into practice. Having shown the possibility of making the run to Buffalo in 7½ hours or so, the company will put on a fast train which will make the trip every day in a much shorter time than is now done.

THE new ore docks of the Escanaba, Iron Mountain & Western Railroad near Escanaba, Mich., are said to be the largest in the world. Their construction occupied about eight months, and cost $281,605. The material used included 6,534 piles, 6,434,331 ft. lumber, 81,329 lbs. cast iron, 981,062 lbs. wrought iron and 733,584 lbs. steel. The dock itself is 1,427 ft. long; the rails on top are 52 ft. above water level, while below are 232 pockets having a total storage capacity of 45,000 tons of iron ore. The approach to the dock is by timber trestle on pile foundations; this trestle is 2,091 ft. long and from 20 ft. to 52 ft. in height; there is also a Howe-truss span of 126 ft. over the Chicago & Northwestern tracks. This dock was built under the direction of Chief Engineer G. M. Willis, with Assistant Engineer E. C. Hollidge in charge of construction.

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AN elevated railroad is now under construction in Liverpool for passenger traffic. It will be, when completed, about 6¾ miles long, running along the water front, where the heavy traffic to and from the docks almost prohibits passenger transit by stage or horse car. The line has two tracks of standard gauge, has stations at convenient intervals, and the cars will be run by electric motors. It is carried on steel plate girders spaced 25 ft. apart; the normal span is 50 ft., but at some street crossings and dock entrances this is increased. The minimum clear headway above the street is 16 ft. At the Stanley Dock entrance a draw-bridge had to be provided. The roadway is composed of steel arch-plates, riveted together and resting at the ends on the bottom flanges of the main girders. The rails will be laid on longitudinal wooden sleepers. The columns carrying the main girders consist of two steel channel-bars riveted to two steel plates, forming a square box column. They are set in cast-iron sockets resting on a masonry bed.

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THE fastest time on record in the waters around New York has been made by the little steam yacht *Norwood*, which has attained the rate of 28 miles an hour, running from the Narrows to Sandy Hook. The *Norwood* was modeled and built by C. D. Mosher, of Amesbury, Mass.; she is 63 ft. 2½ in. long and 7 ft. 6 in. beam. The screw is 36 in. in diameter, and is driven by a triple-expansion engine which has worked up to 400 H.P., with 150 lbs. of steam. The boiler is of the Thornycroft pattern.

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ACTING upon a message from the Governor and a communication from the Railroad Commissioner, Mr. Charles R. Whitman, the Legislature of Michigan in June last adopted concurrent resolutions requesting Congress "to enact such legislation as may be necessary to ensure the adoption on all railroads in the United States of automatic couplers and train brakes; or such other legislation as may be necessary to insure the making up and running of trains without compelling railroad employés to enter between or on the tops of cars while the same are in motion."

Similar action, it is said, will be urged upon the legislatures of other States as soon as possible.

## A NEW CHAIR CAR.

THE accompanying engravings show one of several fine chair-cars recently built by the St. Charles Car Company, at St. Charles, Mo., for the Jacksonville Southeastern Line, of which Mr. William J. Hemphill is Superintendent of Motive Power. These cars were built for the through line between Chicago and St. Louis formed by the Jacksonville Southeastern and the Atchison, Topeka & Santa Fé. Fig. 1 is a side elevation; fig. 2 is a plan, showing arrangement of the seats, closets, etc.; fig. 3 is from a photograph, showing the general appearance of the car; fig. 4 is from a photograph showing the inside of the car and the Scarritt-Forney seats used.

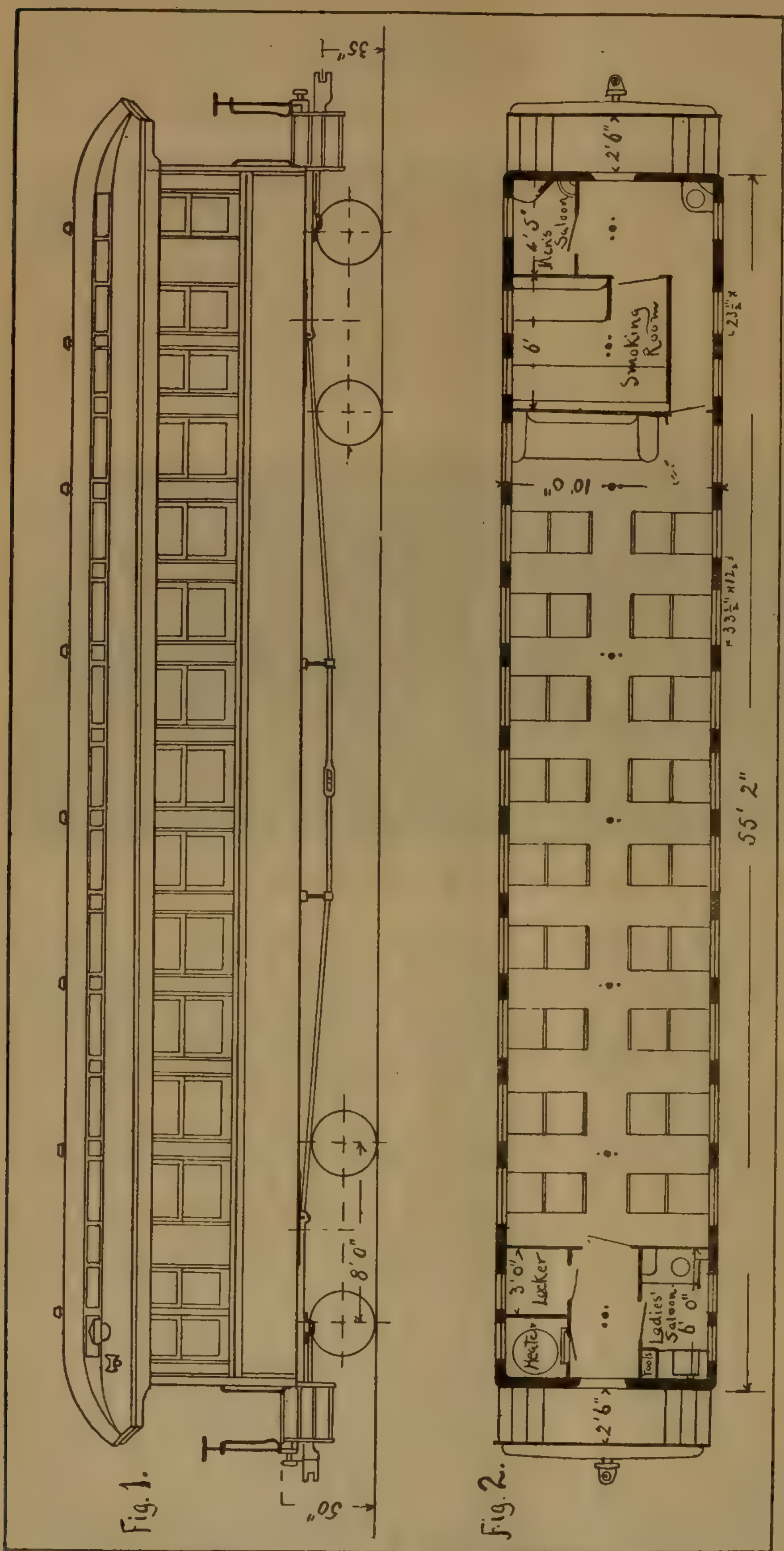
CHAIR CAR FOR JACKSONVILLE SOUTHEASTERN LINE.

The car is 55 ft. 2 in. long, 10 ft. wide over sills, and 6 ft. 8½ in. high from top of sill to under-plate. The body framing is of the St. Charles Company's standard pattern. The flooring is of 1¼ × 3-in. yellow pine, tongued and grooved. The outside is ceiled with ¾ × 2-in. sheathing. The roof is of the standard pattern, the hood having curved ends, with ventilation over end doors.

There are ten large and five small windows on each side, as shown. The large windows have glass 30 × 24 in. in the lower and 20 × 24 in. in the upper sash. The glass in the clear-story is cathedral size, 7¼ × 7 in. The windows have cornice curtains of tapestry, except those in the saloons and heater closet, which are provided with blinds.

As shown by the plan, there are two saloons, a heater closet and smoking-room. The saloons are provided with all the usual fittings, and the wash-stands are of Tennessee marble. The smoking-room has two sofas upholstered in embossed leather. In the main body of the car there is a sofa at the end, and the other seats are of the Scarritt-Forney "twin" type, a pattern which has proved very popular on roads where it has been introduced. Fig. 4 shows very well the general plan and arrangement of these seats; it shows at the same time the interior decoration, which is simple but very neat. The seats are upholstered in plush, the seat ends are of mahogany, and the closets are in natural mahogany; the trimmings are of solid brass. The ceiling is of quartered oak.

The car is provided with the Baker heater with straight piping and the New York Safety Car Heating Company's safety attachment. There are eight Hicks-Smith center lamps and one bracket lamp. The car is wired for electric lights.




CHAIR CAR FOR JACKSONVILLE SOUTHEASTERN LINE.

BUILT BY THE ST. CHARLES CAR COMPANY, ST. CHARLES, MO.

The platforms are the standard Miller type, with wrought-iron draw-bars. The car is fitted with the Boyden brake, with Hodge's system of brake levers. The brake-shoes are the Christie head on the "National" hollow brake beam.

The trucks are four-wheeled trucks of the St. Charles Company's standard pattern, with wheels spaced 8 ft. apart. The pedestals, journal boxes and journals are the M. C. B. standard pattern. The axles are M. C. B. standard, of iron, and the wheels are 33-in., double plate, weighing 600 lbs. each. The bolster springs are quintuple elliptic $3 \times 1\frac{1}{32} \times 36$ in., and the equalizer springs are three-coil round-bar spiral $8 \times 10$ in.

The vestibules are covered with oil-cloth and the body of the car with Wilton carpet. The minor fittings include 18 umbrella holders and six card tables. Large mirrors are placed on the bulkhead partition, and the toilet rooms are very neatly fitted up.

The seating capacity is 35 in the body of the car and 7 in the smoking-room, making 42 in all. It is an excellent example of the latest practice in passenger car construction.

## THE SINKING OF THE "BLANCO ENCALADA."

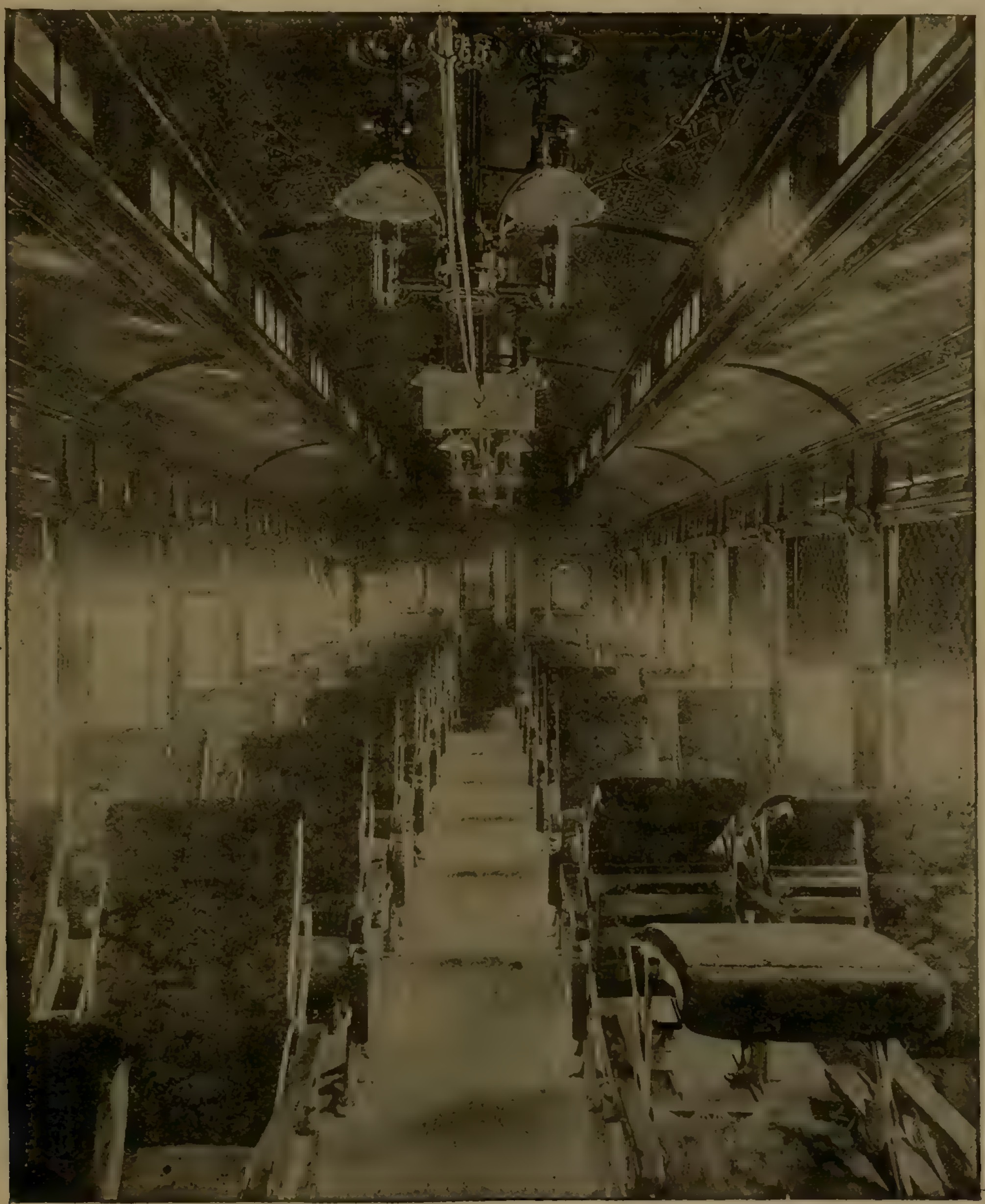
(From London *Engineering*.)

We have received from a correspondent copies of the official reports of the sinking of the *Encalada*, written by Captain Goni, the commander of the vessel, and by the senior officer in charge of the attacking torpedo gun-boats the *Almirante Lynch* and *Almirante Condell*. The details are very meager, but they have the advantage of being written by those who are acquainted with the subject of naval warfare, and are, therefore, more satisfactory than the newspaper reports hitherto received, and which were apparently written more with a view to supplying a sensational column of descriptive writing rather than a true narrative of events.

Captain Goni's report is very brief. He states that his vessel was attacked by the *Lynch* and *Condell*, and that six out of the seven torpedoes they fired struck the ship. That is a remarkable average, and further details of damage done would be of great interest. As the vessel is sunk in shallow water, her bridge appearing above the surface, and as there was a diver on the spot, it is to be hoped we may subsequently get some particulars on this head. Captain Goni simply states that "the torpedo catchers were hotly cannonaded by the *Blanco* before she sank;" and that about half of the crew was lost, among them being all the engineers.

The part of the report of Captain Moraga, the commander of the torpedo vessels, which refers to the action is a little more detailed, and is as follows:

A little before 4 A.M. (April 23) I entered Caldera Bay, and as soon as the light of the moon enabled me to do so, I made out the position of the revolutionary vessels. Meanwhile the *Lynch* followed in my wake at a distance of about 50 meters. At half-speed I pointed the bow at the *Blanco* or the *Cochrane*; I was not able then to see which of the two I had ahead. There was another vessel at the side which I took to be the *Huascar*. At a distance of approximately 100 meters I fired the bow torpedo, which passed just ahead of the iron-clad, almost touching it, and which, I think, struck a vessel lying near. Immediately after this first shot I sheered off to the starboard, and at a distance of about 60 meters Lieutenant Vargas dexterously fired the first port torpedo, which must have struck the bows of the attacked vessel. At the same time I ordered Lieutenant Rivera to fire from the same side the after torpedo. Between the sending off of the second and third torpedo the iron-clad opened a rapid and persistent fire upon my vessel, making use of her mitrailleuses, rapid-firing guns and rifles. After firing the first torpedo I went ahead at full speed. The iron-clad's fire continued to be directed against my vessel, as she did not observe that the *Lynch* was performing the same manœuvre as the *Condell*. The *Lynch* approached to within a short distance, when she fired her bow torpedo, which missed. Steering off to star-



INTERIOR OF CHAIR CAR, JACKSONVILLE SOUTHEASTERN LINE.

board, the *Lynch* fired her second torpedo, which struck the *Blanco* about amidships, and two minutes afterward the revolutionary vessel foundered. Seven minutes more or less elapsed between the firing of the first torpedo from the *Condell* and the last from the *Lynch*.

The accompanying sketch shows, in fig. 1, the *Condell's* and in fig. 2 the *Lynch's* attack. In both *A* is the *Blanco Encalada; B* the *Condell; C* the *Lynch*. The dotted lines show the course of each torpedo fired, and are numbered in order, 1 showing the course of the first torpedo, 2 the second, and so on.

It will be seen from this account that five torpedoes were fired, not seven, as stated by Captain Goni, and that three of them hit the mark. A good deal has been said in naval circles here about the *Encalada* not having her tor-

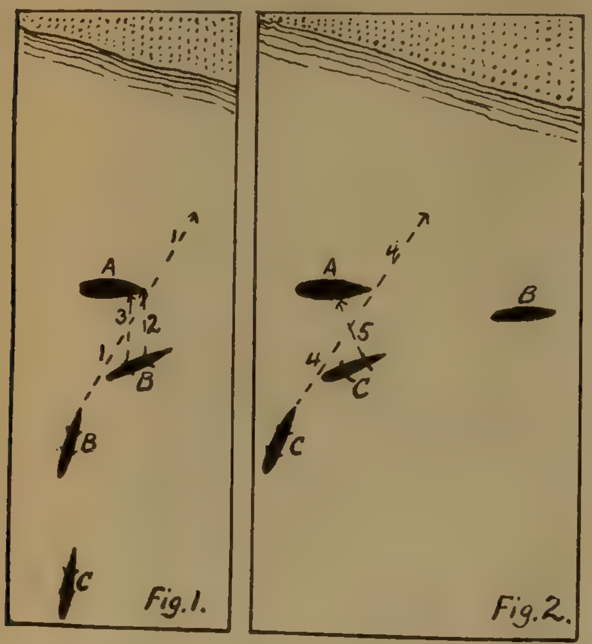


Fig. 1. Fig. 2.

pedo-nets rigged; and a good deal of censure has been passed upon Captain Goni on this account. As a matter of fact, we believe the vessel was not supplied with nets—at least none were fitted when she was overhauled and re-armed at Elswick a few years ago; and it is improbable that this means of defense has been since supplied. We doubt, however, if any defense of that nature could have saved the ship. The attack was well planned and well executed, the *Lynch* well seconding her leader's efforts—always a matter of great importance in torpedo-boat attack. The first torpedo that hit—the second fired—would probably have so disorganized the net defense that the second would have got through to the vessel's side. If, however, both these torpedoes had expended their power on the net, there is, we think, little doubt but that the *Lynch's* torpedo would have got through; but even had that been entangled and exploded, the latter vessel had another torpedo left on the port side, while both vessels had two more torpedoes on the starboard side. Where the Congressional vessels were to blame, however, was in not sending out the vidette boats. A good system of pickets is a far more effective protection against such attacks than any amount of nets rigged out on booms. The lookout vessels need not necessarily be steam craft, although, of course, the latter are preferable, as they enable a longer line to be patrolled; but one man in a dingy with a blue light can give just as good an alarm as a steam pinnace with a dozen hands on board.

A point worth noting is the failure of both bow torpedoes. Both boats missed in the same manner—namely, the weapons going across the bows of the attacked vessels, as shown in the annexed sketch. No doubt the boats overdid a good thing and delayed too long in firing the bow weapon; or probably the helmsman got nervous and began to edge off too soon when he saw the hull of the iron-clad suddenly looming up through the dull moonlight. This is always a danger with bow torpedo fire when the tube is built into the vessel so that the weapon can only be directed by manœuvring the craft herself. For a single shot we should prefer the built-in bow gun. In that case the boat should run up end-on until well within striking distance, and having fired, sheer off only sufficiently to pass close under the bow or stern. Of course such a proceeding is extremely risky; but for a torpedo-boat to attack a well-armed ship is a matter which requires men to forget that they are likely to be shot, and the boldest course is often the safest. When it is required to fire torpedoes from training guns on deck, the manœuvre of running under the bow or stern is inadmissible, or rather undesirable, as the reduced area of target due to the end-on position of the ship attacked would lessen the chances of hitting. It may be said that the bow fire is an extra chance if not a very good one; but it must be remembered that the chances which depend on the expenditure of a Whitehead torpedo must necessarily be very few, and we think it is doubtful policy to have one of them locked up in a gun that can only be pointed by moving the whole vessel with the rudder. That, however, is a question upon which there is much to be said on both sides, and further experience may be directly opposed to that gained by the fight in Caldera Bay.

## NOTES ON COMBUSTION.

By C. Chomienne, Engineer.

(*Continued from page* 413.)

### THE THEORY OF SMOKE.

We know that pure carbon burning, even with an insufficient supply of air, never produces smoke. It is the same with charcoal and with coke. The hydrocarbons, on the other hand, give much smoke whenever they are burned with too small a supply of air. The experiments of M. Berthelot have proved that when we heat certain hydrocarbons to a fixed temperature, we produce a new hydrocarbon, more condensed, with a deposit of pure carbon. Let us see what takes place on a grate charged with coal.

If we assume that this grate is covered with coal half consumed, and that it contains only coke, in an ignited state, it will not produce smoke, but if we throw fresh coal upon the fire we see at once black smoke rising from the mass and passing into the smoke-stack. Quickly the smoke diminishes in quantity and ends by disappearing entirely until another charge of coal is thrown upon the fire. Let us see what has been found in this case. At the moment when the coal touches the ignited surface, the hydrocarbons which it includes feel the action of a high temperature and their distillation is produced. These vapors coming into contact with the air immediately burn and consume the oxygen surrounding them. If no fresh air comes to renew the supply of oxygen a quantity of gas is formed which will be carried into the chimney in the same state in which it was when it left the grate; that is, imperfectly burned. This explains the presence of hydrocarbons in the gaseous products of combustion.

There is still another thing to take into consideration—the dissociation of gases, an admirable discovery which is due to M. Sainte Claire Deville.

When a compound gas is brought to a sufficiently high temperature the elements which compose it will separate, but if the mixture resulting from this separation is quickly cooled, we find instead of the compound gas which we had originally a simple mixture. If, on the other hand, the cooling is slow, the elements will recombine and we will have the original compound gas.

In consequence, at the moment when the hydrocarbons are disengaged and are carried to a very high temperature they become a mixture of carbon in a state of vapor

and of hydrogen. If a sufficient quantity of air is furnished the combustion will be complete ; if not, it will be imperfect, and we will have the first case when the cooling is slow ; but if the cooling is rapid—as may happen if the gases come in contact with the passages or with the bridge or even with a current of cool air—the carbon will appear in the form of black smoke and the hydrogen will remain free. This accounts for its presence in the gaseous products of combustion and also for that of a new quantity of hydrocarbons which are formed by what M. Deville has called a partial recomposition.

In the passages of a boiler all these phenomena are partially reproduced. When the gases touch the walls of the boiler, which are at a comparatively lower temperature, smoke is produced by the precipitation of the carbon. There also results the rapid heating of the hydrocarbons on the grate, producing the reaction shown by M. Berthelot, and the rapid cooling of the gases resulting in the reaction of M. Deville ; these are the two principal causes of the formation of smoke. There is always a lack of air, which is, if not the only cause, at least a necessary cause. In spite of this, and according to careful experiments, smoke, if black and as thick as it can be even when it is produced by design and by not giving the fire-box a sufficient quantity of air, will not represent a loss of more than 1.5 per cent. If the supply of air is increased a little this loss will fall to 0.5 per cent.

As we have before stated, the composition of the gaseous products of combustion varies very greatly as the smoke is black, light colored or almost colorless. Each of these states correspond to a different degree of loss, and the blackest smoke is that which shows the most imperfect combustion. This is generally true, but it is hardly necessary to believe that in all cases the loss shown would be proportional to the color of the smoke, since it may happen that colorless gas includes carbonic oxide, which constitutes a greater loss than that resulting from black smoke.

In order to know how during a definite time—100 minutes, for example—the three conditions of the smoke are presented, M. Burnat made a series of experiments. He took the most unfavorable conditions and used an oily coal, which is certainly the fuel most apt to give rise to loss of heat by incomplete combustion. He carried the combustion of carbon to its maximum point with an insufficient quantity of air in such a way as to produce as much black smoke as possible ; using 2 kg. of coal per hour per square decimeter of grate surface, and a supply of 6 cub. m. of air to 1 kilogram of coal, he found that black smoke was given out for 32 minutes ; gray or light colored for 33, and colorless for 35. He then tried the reverse conditions ; that is to say, he reduced the consumption to a minimum, 0.54 kg. of coal per hour per square decimeter of grate with a large supply of air, 16 cub. m. per kilogram of coal. He then found that black smoke lasted 4 minutes ; gray, 27, and colorless, 69.

For his third trial he adopted the average combustion ; that is to say, about 0.75 kg. per hour per square decimeter of grate, with a supply of 15 cub. m. of air per kilogram of coal. In this case he found that black smoke lasted 10 minutes ; gray, 30, and colorless, 60.

M. Burnat afterward analyzed each of these kinds of smoke, with the results shown in the table below :

| Component Gases. | Black Smoke. | Gray Smoke. | Colorless. |
|---|---|---|---|
| Carbonic acid | 11.00 | 8.00 | 10.86 |
| Oxygen | 7.20 | 12.90 | 11.48 |
| Carbonic oxide | 1.55 | 0.18 | 0.00 |
| Hydrogen | 0.58 | 0.93 | 0.33 |
| Nitrogen | 79.67 | 77.99 | 77.33 |
| Total volume | [illegible] | 100.00 | 100.00 |

These analyses do not show carbon except in combination with oxygen in different proportions.

### EVILS OF INCOMPLETE COMBUSTION.

It follows from this examination that the loss due to smoke under good conditions of combustion is quite insignificant. It is true that we look for smoke-consuming apparatus not only for reasons of economy, but for others connected with property, and especially with public health.

In fact it is not carbonic acid which is most noxious in smoke. It is dissipated physically in the air, while the carbonic oxide is much more dangerous. It attacks the organs of breathing, and is really a very deleterious gas. It is especially dangerous because its density is 0.97, almost equal to that of the air, and for this reason it is apt to be uniformly diffused through the atmosphere, while carbonic acid, having a density of 1.53, or one-half more than the air, is always found close to the surface of the ground.

A few thousandths of carbonic oxide in the air are sufficient to destroy the most robust health, and on an average from 1.2 up to 3 per cent. is found in smoke. From that statement one can judge the mass of poison which is daily diffused in the air. The very poisonous quality of this gas results chiefly from the property which the blood possesses of absorbing it in the same degree as it is introduced into the lungs and transforming it into a poison which acts upon the nervous centers.

As to carbonic acid it can be absorbed in a very considerable quantity without injuring animal life. There are fortunately many causes for the absorption of this gas. Water transforms it into carbonates of iron or other oxides, and plants especially absorb considerable quantities of it. There is thus an equilibrium which we cannot admire too much, and which is for us an essential condition for life.

As nature thus charges herself with the disposition in large part of the carbonic acid, it devolves upon man to prevent in every possible way the formation of carbonic oxide and to prevent also the injury which it causes in the human organism.

### NECESSARY CONDITIONS OF COMPLETE COMBUSTION.

We must now study the methods of arriving at a practical result. First we should not entrust the management of boilers to unskilled persons ; it is necessary to employ experienced and intelligent firemen who know how to manage their fire, charging with coal frequently and at the proper time, and regulating the draft for each case and for each kind of boiler in such a way that the loss by incomplete combustion and through the smoke-stack may be reduced to a minimum.

The automatic apparatus of M. Poindron changing the damper at the moment of firing or of arranging the fire produces an excellent result. It stops to a certain degree the abrupt supply of cold air under the boiler or upon the tube plate, and accordingly those coolings and contractions which are very injurious.

The manner in which the fireman works has a very great influence on the work of a boiler. The employment of poor firemen results in a consumption of fuel varying frequently from 25 to 50 per cent. more than a good fireman would require to vaporize the same quantity of water ; and moreover the boiler will be sometimes overworked, which may occasion serious accidents.

The layer of fuel on a grate should never be less than 0.06 m., nor more than 0.16 m. in thickness according to the nature of the coal employed, the size of the lumps and the draft. With a very strong draft it may perhaps go as far as 0.20 m. in thickness.

If the layer of fuel is too thin and the fireman not very attentive, at points on the surface of the grate holes will be formed in the fire, through which the air passes without being deprived of its oxygen, or else lumps or piles in which the coal will be distilled without being completely burned.

The space between the grate-bars should be such that the fuel will fall through into the ash-pan only in the state of ashes or cinders vitrified by the temperature of the fire-box.

It is necessary to expose to the radiating or direct heat of the fire-box the greatest possible surface of the boiler in order that the greatest quantity of heat may be transmitted directly through its walls.

According to Peclet, in a locomotive boiler the quantity

of heat transmitted by direct radiation is almost three times that transmitted by contact for an equal surface.

In all boilers the fuel placed upon the grate acts in two ways. Combustion properly so-called gives the greatest amount of heat, since the gases traveling through the tubes are gradually cooled and give up only a part of the heat which they hold before reaching the smoke-stack. This difference of action is especially notable in boilers of the locomotive type with internal fire box and tubes, because in these the gases after having been burned in the combustion chamber suddenly encounter a large surface of a much lower temperature. The difference is not so marked in boilers of the Cornish type or in those without tubes or with return flues, but it still exists to some extent.

"MORTUARY" STATION, SYDNEY, NEW SOUTH WALES. STREET FRONT.

While internal fire-boxes are favorable to the rapid absorption of heat, they have also some inconveniences. The height above the grate cannot be much more than 0.40 m., and we cannot use in them coals with a large proportion of gas, since the gases on coming in contact with the plates are cooled and cease to burn. The fuel to be employed in such boilers should have only a small proportion of volatile matter and should burn easily, since the walls of these fire-boxes do not attain a temperature of over 152° C., while in external fire-boxes the radiated heat of the brick walls will rise to 600° C., which is an important aid to combustion.

Let us see why the combustible gases and the oxygen of the air in excess do not combine in the path which they travel from the layer of coal on the grate to the smoke-stack. It is evidently because these gases on leaving the grate come immediately in contact with the boiler, which is, as we have said, a body sufficiently cool to partly extinguish these gases. We see, in fact, that the boiler at the pressure of 75 lbs. is at near 150° C., while carbonic oxide will not burn until it is at least at 800° C. and the hydrocarbons at 700° C., on account of the extreme dispersion of their particles. It follows then that the gases which leave the fire-box at a very variable temperature, not often at over 800° C., lose very quickly in contact with the boiler heat enough to reduce them to the temperature where they can no longer combine with oxygen. If it is possible then the complete combustion of all the gases leaving the fire must be effected before they are cooled below the temperature where the fire is extinguished, whether it be 800° or 700°.

For the oxidation of a fuel and its volatile products—that is, for the combustion to be complete—it is necessary to break up the parallelism of the gaseous currents rising from the grate. When coal is distilled on an ordinary grate there are produced parallel currents of gas and of air, and combustion exists only on the lines of contact. When the air has lost one-half of its oxygen, and when the flame includes 10 per cent. of carbonic acid, this combustion ceases and there follows the production of black smoke and the consequent losses. Now if in any way there is a lateral injection of air—above the grate, for in-

stance—the gases will be forced to mix while they are still at a temperature above that of extinction. It is evident that they will combine, and we will thus obtain a much more complete combustion.

As to the quantity of air which must be introduced above the grate to produce an energetic mixture of gases close to the point where they are formed, it may vary between 10 and 20 per cent. of the total volume necessary to burn the fuel. Thus if we suppose that it requires 15 cub. m. of air to burn 1 kilogram of coal, we can admit from 12.5 to 13.5 cub. m. below the grate and from 2.5 to 1.5 above. If not more than 1 cub. m. should pass through, that would still be sufficient to break up the parallelism of the gaseous currents and to produce in the zone of high temperature the intimate mixture of all the elements which ought to combine. This mixture ought to be made at once and before the gases are too much cooled, in order to prevent the impoverishment of the air of its oxygen and the final production of carbonic acid.

If the air introduced above the grate can be heated to the temperature where it will inflame at once the gaseous products, the combustion will be much improved.

As can be easily understood, a grate which does not receive less than 10 to 15 per cent. of air above the fire cannot give good combustion when the flame is carried some distance from the fire-box; the parallel currents of gas, some of them consisting of combustible gases and carbonic acid, others of air charged with carbonic acid, all combustion becomes impossible. In consequence, where the temperature is too low at the origin in the fire-box, there is a loss by imperfect combustion and by black smoke if the coal is charged with gas. Jets of air break up the parallelism of the gaseous currents rising from the grate, the mass of gas is mixed to some degee in passing over the bridge where the section is contracted in comparison with that of the smoke-stack, and immediately the velocity of the currents decreases in the enlargement produced by the combustion chamber. The gases and air are completely mixed, the combustion is finished, and not until then do the products of combustion pass into the tubes.

(TO BE CONTINUED.)

## AN AUSTRALIAN RAILROAD STATION.

THE accompanying illustrations, which are reproduced from photographs, show two views of a railroad station of very neat and tasteful design, which is placed at the entrance to a cemetery near Sydney, New South Wales, and is called the "Mortuary" station.

The first or larger engraving shows the street front. The building, as will be seen, stands on a slight elevation above the road, and its distinguishing features are the large arched porch and the tower surmounting it, which stand well out from the rest of the building. The offices and waiting rooms are placed on this front, and the entrance is by a wide flight of steps from the street.

"MORTUARY" STATION, SYDNEY, NEW SOUTH WALES. CEMETERY FRONT.

The second or smaller engraving shows the inside or cemetery front of the station. This is an open train-house with the roof supported by stone arches. The train standing in the house is apparently a funeral train.

The station is notable for its excellent design and adaptation to the surroundings.

## TAKING THE PROFILE OF A RIVER BOTTOM.

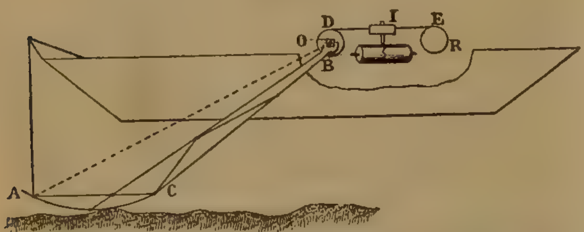
AN ingenious apparatus, invented by Herr Stecher and constructed by Herr Zeuner, at Dresden, was exhibited at the recent Internal Navigation Congress at Frankfort. It was specially designed for obtaining a profile of the bottom of the River Elbe, but might be applied with advantage in other places.

The apparatus consists of an arm or girder of angle-iron, *A B* in fig. 1, ending at *A C* in a curved point intended to slide along the bottom of the river. The other end of the arm is fixed by means of a yoke to a horizontal

shaft turning in bearings mounted on a boat. It will be seen that as the boat moves whenever a change occurs in the bottom, the curved end *A C* will rise or fall and will cause the shaft *O* to turn to a corresponding degree.

On this shaft a flexible band *D E* is rolled, which is kept in tension by means of a spring drum *R*. On this band is mounted a holder carrying a pencil *I*, the point of which traces, while the boat moves, upon a roll of paper which is gradually unrolled by a uniform movement, the

Fig. 1.



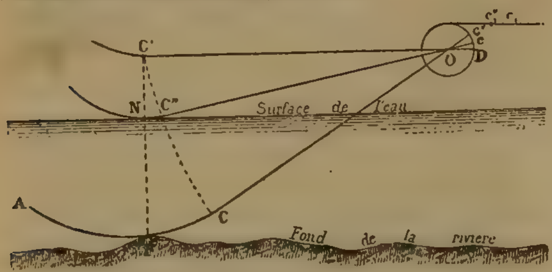




Fig. 2.

profile of the bottom, upon which the curved end of the arm slides.

A second pencil fixed in a position, which is determined at the commencement of the operation, traces on the roll of paper the line of depth—that is to say, the line corresponding to the surface of the water.

Lastly, a third pencil held by a spring permits the operator to mark, as the boat passes, the distances and other points on its course.

To explain the theory of the apparatus, the curved end *A C* of the arm is a section of a circle, which has the point *O* for a center and *O C* for a radius. It follows that $C'\,F =$ arc $C\,C'$; $C'\,N =$ arc $C'\,C''$; and $C'\,F - C'\,N =$ arc $C''\,C$.

Now $C\,F - C\,N$ is the depth looked for. This depth is then equal to the arc described by the arm on the shaft *O*, when the long arm passes from the position *O C* to $O\,C''$ multiplied by the ratio $\frac{O\,C}{O\,D}$. But the arcs described by the shaft *O* are equal to the horizontal displacements of the flexible band; that is, to the displacement reduced by the pencil on the roll of paper. From this it results that the line obtained on the paper gives on the scale $\frac{O\,D}{O\,C}$, the depth of the river according to the line on the bottom followed by the arm *A C*.

The engineer in charge of the improvement of the Elbe says that the results obtained with this apparatus have been very satisfactory. In practice it was found that at smooth water the most convenient speed to obtain a given diagram was from 3½ to 6 miles an hour. The whole apparatus cost without the boat $175, including $25 royalty paid for the patent.

## AN ACCURATE BLUE-PRINTING APPARATUS.

By George I. Rockwood, B.S.

The comfort of having one's blue-prints perfectly distinct and correct to scale is no slight one, especially if the scale is small and the drawing large, as, for instance, in the case of building plans. But it is a comfort rarely enjoyed, for prints are almost always distorted out of all truth, and often contain blurs due to lack of close contact with their negatives when printed.

There are two causes for the distortion of prints; in the first place, the printing frame may not have been so exposed that the sun's rays came perpendicularly upon the glass. This is of prime importance if the print is to be an accurate copy of the draft. In the second place, care may not have been taken to use a prepared paper which could stand the wetting and drying process without "coming and going."

In a not uncommon printing apparatus a large heavy piece of plate glass rests horizontally on a back-board covered with a thick and pliant felting, the board being mounted on four grooved wheels which fit into one half-inch half-round iron rails. The rails extend out of the room upon brackets fastened outside the window. The operator simply lifts up the glass, laying the paper and negative under it upon the felting, lowers the glass and runs the frame out-of-doors. This, although the simplest form of blue-printing apparatus using glass, nevertheless fails to give uniformly good, clear prints, especially if the tracing is in any way creased or wrinkled, for the very reason that the felting so commonly employed *is* pliant, and if used at all, should be made to serve simply as a backing to *hard gasket rubber*, say $\frac{1}{16}$ in. thick. Experience has shown that the best way to secure good contact of paper to glass is to compress the paper firmly between the glass and a rubber-lined back-board by means of springs uniformly distributed over its surface.

The problem, then, of designing a blue-print frame to give the best results is to provide in a simple and convenient way for pressing the back-board firmly against the glass, and to provide means for turning and inclining the glass into a plane perpendicular to the sun's rays. The accompanying drawings represent a blue-print frame so designed as to fulfill the above conditions. Blurring is effectually prevented by clamping the tracing and prepared paper tightly up against the plate glass in hard and uniform contact, and the glass may be easily and quickly secured in a plane perpendicular to the sun's rays without resorting to any complicated or cumbrous means.

Figs. I and II show a plan and sectional view of the frame itself. Figs. III and IV show side and end elevations of the frame upon its truck, opened to receive the tracing and paper. The frame *A* holds the plate glass *B* in the same manner as a pane of window glass is held in its casing, but instead of using putty, narrow strips *a* should be screwed to the inside of the frame around its edges; these should not fit so tightly down upon the glass as to confine it rigidly, but must leave it with a little play. The tracing and paper are pressed between the glass and a back-board *C* composed of several strips cleated together at *b b b b* and covered with felting and sheet rubber tacked to the board around its edges. To press this board quickly and firmly against the glass the device illustrated was invented, consisting of three arms *D D D*, hinged at *f*, each carrying three springs and a cam-lever *E* hinged at *e*. After laying the paper and negative upon the back-board the frame is lowered upon its hinges *g*, until the glass rests upon the back-board, when a slight push upon each cam-lever easily locks its arm *D* into place and compresses its springs against the board. Figs. I and II show the arms thus clamped into place, while figs. III and IV show the frame open and ready for use.

The fixture illustrated in fig. V and shown in figs. III and IV at *H* is for clamping the frame at any desired angle upon the long rod pivoted upon the truck at *J*, and explains itself.

Two frames, *K* and *L*, support the printing frame proper, *K* being swiveled upon *L* to allow turning the frame about in any direction to meet the sun. The trolleys which support the apparatus should be drilled and turned on an arbor, as they will run enough more smoothly to compensate for the extra expense. The upper frame *K* should rest most of its weight upon one or two washers at the pivot-bolt so that it may be easily rotated without binding by friction on the lower frame.

It has not been found necessary to locate the frame in a dark room, but it is a good plan to have a large shallow

We hope to take up the question of springs in the next article.

(TO BE CONTINUED.)

## AN ENGLISH LOCOMOTIVE FOR SUBURBAN SERVICE.

THE accompanying illustration, from the *Railway Engineer*, shows a new tank engine of a class lately designed by Mr. William Adams, Locomotive Superintendent of the London & Southwestern Railway, for working the heavy suburban traffic of that road. They are intended to take the place of a lighter class of engines, and the company is now building 40 of them at its Nine-Elms shop; several of them are already at work.

The engine, it will be seen, is of the Forney type, but follows English practice in the plate frames and inside cylinders. It is carried on four coupled driving-wheels and a four-wheeled truck.

The boiler barrel is 50 in. in diameter and 9 ft. 3½ in. long. There are 210 tubes 1¾ in. in diameter and 9 ft. 9 in. long. The grate area is 13.8 sq. ft.; the heating surface is: Fire-box, 90; tubes, 898; total, 988 sq. ft.

The cylinders are 17 in. in diameter and 24 in. stroke. The driving-wheels are 58 in. in diameter and the truck wheels 36 in. The driving-axles are spaced 6 ft. 10 in. between centers, and the distance from center of rear driving-axle to center of truck is 11 ft. The truck axles are 5 ft. apart. The total length of the engine over all is 30 ft. 8½ in.

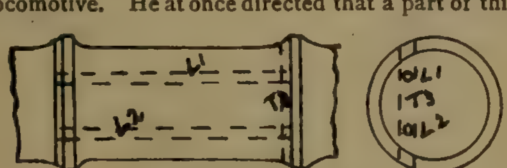
The water-tank holds 800 galls. of water, and the coal-box 2¼ tons of coal. The total weight of the engine in working order is 99,800 lbs., of which 66,100 lbs. are carried on the four driving-wheels, and 33,300 lbs. on the truck.

In building these engines cast steel has been used wherever possible, a practice which Mr. Adams has followed for some time. Those already completed are giving very good results in service. This engine might be compared with the New York Central Suburban locomotive which was described and illustrated in the September number of the JOURNAL, which is a little heavier.

## A MATTER OF IMPORTANCE TO RAILROADS.

THE not infrequent breaking of crank-pins of locomotive engines is a source of accident and expense, and a method of avoiding it, without making the pins unnecessarily large and heavy, is very desirable.

The Second Vice-President of the Lehigh Valley Railroad, on a trip over the line recently, experienced some delay on account of the breaking of the main crank-pin of the locomotive. He at once directed that a part of this pin be sent to the Bethlehem Iron Company for analysis. This was done, and showed a good quality of steel. Pieces were then subjected to physical test, which also indicated a good grade of metal. Then the pin had an inch hole drilled through it, and was oil-tempered and annealed. After treatment a test specimen was cut from the pin and subjected to a physical test. The result was an increase in tensile strength of 7.7 per cent.; in elastic limit of 36.6 per cent.; in extension of 34.9 per cent., and in contraction of area at point of fracture of 39.1 per cent.



The accompanying table shows the result of this test. The first three lines, specimens *L.*1, *L.*2 and *T.*3, show tests of specimens of the metal, both longitudinal and transverse sections. The small diagram, fig. 1, shows the way in which the specimens were cut from the broken pin. The transverse specimen, marked *T.*3, was taken from the smooth part of the fracture. The fourth line, marked *H.S.L.*2, shows the results obtained from the test of the metal after treatment. A study of this table will tell the story at once.

The results of this test were so striking that instructions were at once given that 20 locomotives now being built at the Baldwin Locomotive Works for the road should be furnished with steel crank-pins oil-tempered and annealed, and all pins hereafter used will be of the same character. It has also been decided that all pins hereafter used upon pin-connected bridges shall be treated in the same way.

It may also be mentioned that the Lehigh Valley Company is now having two sets of locomotive tires oil-tempered and annealed, and excellent results are expected from the treatment. In fact, the results of these experiments would seem to indicate that it would be well to have the guides, connecting-rods and other parts of the locomotive now made of steel treated in a similar way.

## THE GLASGOW HARBOR TUNNEL.

(From *Industries*.)

THE work on this tunnel was begun in May, 1890, and it is expected that it will be finished early next year. It extends under the river Clyde, where it forms the harbor of Glasgow, and is intended to furnish a crossing for passengers and vehicles at a point some distance below any of the present bridges and where a bridge of any kind except at a very high level would be an obstruction to navigation. It is built by a corporation known as the Glasgow Harbor Tunnel Company, the contract being taken by Hugh Kennedy & Sons, Partick, Scotland.

The work consists of three separate tunnels, two being intended for vehicles and one for foot passengers. The approaches to the tunnels are formed by circular shafts, in which will be fitted flights of stairs and hydraulic elevators. These elevators will be made capable of taking maximum loads of 10 tons, and will be so arranged as to avoid any delay in ascending or descending the shafts. It will be seen by the plan that all three tunnels connect at each end with the same shaft.

Each shaft is circular, and has a diameter of 80 ft.;

TEST OF DRIVER PIN BROKEN JULY 31, 1891, ON ENGINE "IDLEWILD."

| Mark on Specimen. | Dimensions. | | Test. | | | | Appearance of Fracture. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| | Size. | Length. | Tensile Strength. | Elastic Limit. | Per cent. Extension. | Per cent. Contraction. | | |
| *L.* 1 | 0.499" | 2" | 88,970 | 39,880 | 17.25 | 43.50 | Irreg. gray cryst. specks. | Specimen cut from pin as received. |
| *L.* 2 | 0.499" | 2" | 88,460 | 39,880 | 17.25 | 43.50 | " " " " | " " " " " " |
| *T.* 3 | 0.500" | 2" | 94,220 | 39,720 | 16.85 | 21.49 | Cryst. gray spot on edge. | " " " " " " |
| *H.S.L.* 2. | 0.498" | 2" | 97,540 | 54,430 | 23.10 | 50.31 | Dense gray lipped. | From piece of pin after boring hole 1" in diameter, and oil-tempering and annealing. |

Specimens all from crank-pin Lehigh Valley Railroad locomotive No. 416, broken in service.
Analysis: Carbon, .53; manganese, .59; phosphorus, .047; sulphur, .069; silicon, .170.

that on the north side being 72 ft. 6 in. in depth, and that on the south side being 3 ft. deeper. The excavation of the shafts or walls is carried on inside an open double-skinned lining, which descends by its own weight as the removal of material proceeds. The work of excavation has been performed by hand labor filling skips worked by steam cranes situated on the surface. The skins of the lining are composed of cast-iron plates, each 4 ft. long by 2 ft. in depth, with a flange inside all round 3 in. in depth, and of ½-in. metal throughout. The plates are bolted together by ½-in. bolts, spaced 12 in. apart, about ⅛-in. space being left between the flanges for wedging with soft wood, a mode of packing the joints which has proved highly satisfactory and water-tight under considerable pressure. The skins are tied together at the top of each tier of plates by malleable iron ties, 3 ft. deep by ½ in. thick, secured to the flanges by ½-in. bolts. The lining is armed with a cutting edge to facilitate its descent. The space between the inner and outer skins of the lining is filled with concrete composed of five parts of broken stone and sand to one part of cement. As the lining descends, fresh segments are added. Both shafts have now been successfully sunk to their full depth, that on the north side passing entirely through running sand. The pumps had, however, no difficulty in coping with all water met. On the south side an inclined bed of boulder clay was met after passing through the running sand, and it was found necessary to weight one side of the caisson to insure vertical descent. The boulder clay is of a particularly hard and stiff nature, and affords an excellent foundation for the caisson.

Passing to the tunnels, which, as we have explained, are three in number, two for vehicular traffic and one for passenger traffic, their construction will be noted from the accompanying cross sections, partly lined with brick, fig. 3, and partly with cast iron, fig. 4. The tunnels are only 2 ft. apart from each other, and their crowns are about 15 ft. below the river bed, allowing therefore ample margin for future dredging operations. In the boulder clay, where the tunnels are brick-lined, their diameter is 18 ft., while beneath the river, where cast-iron segments will be employed, the diameter is 2 ft. less.

The portion through boulder clay, fig. 3, is constructed on a concrete invert flooring, with circular brick lining composed of five rings of brickwork set in cement. The west tunnel is constructed for 150 ft. under the river on the south side, and preparations are in hand for commencing work with the second shield in the east tunnel, which is now driven 100 ft. also from the south side. The construction of the tunnel so far calls for no special remark. The work has been done in 10-ft. lengths, and in the customary manner. A few boulders of size have been met with, but their removal has been readily effected. The cast-iron lining of the tunnels, see fig. 4, will be composed of segments in rings 18 in. long. Each segment will be

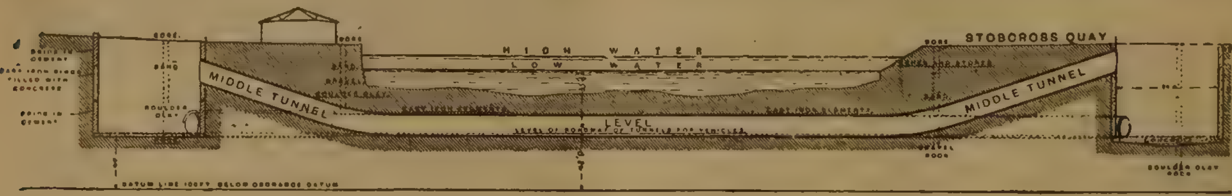



FIG. 1.—TRANSVERSE SECTION OF RIVER, SHOWING TUNNELS AND SHAFTS.

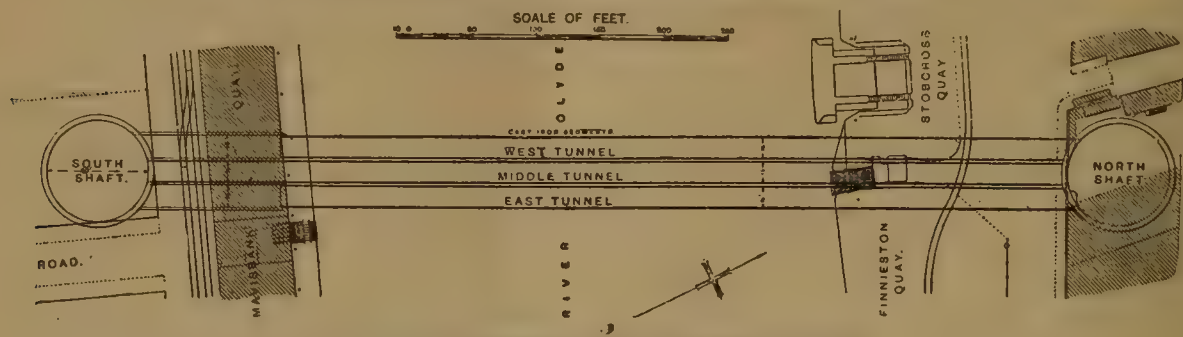



FIG. 2.—PART SECTIONAL PLAN OF TUNNELS AND SHAFTS.

THE GLASGOW HARBOR TUNNEL.

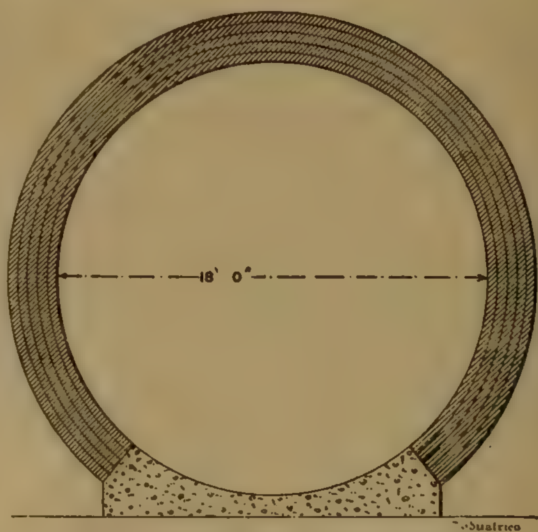



FIG. 3.—SECTION OF BRICK LINING.

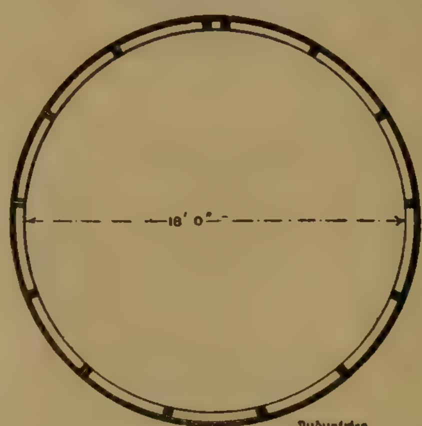



FIG. 4.—SECTION OF CAST-IRON LINING.

about 4 ft. × 18 in., except at the top of the tunnels, where smaller pieces about 9 in. × 18 in. will be introduced.

Each segment will have a flange all round the inside 6 in. deep, measured from the outside of the body of the plate. The body of each segment will be 1 in. thick, and the flanges 1½ in. thick. The segments will be joined together with ¾-in. bolts about 9 in. apart, leaving a space of about ⅛ in. between the flanges for wedging up with soft wood packing, and thus securing a perfectly water-tight joint. The passenger tunnel will be constructed throughout of cast-iron segments, and will have flat stairs at each end in gradients of one in three, thus obviating the necessity of hoists.

As regards the materials used in the undertaking, the bricks are specified 9 in. × 4½ in. × 3½ in., with usual requirements as to soundness, shape, and thorough burning, saturation in water previous to use being likewise required. The mortar is specified to be of the best Portland cement and clean sharp sand, in proportions of one to three. The Portland cement is required to be extremely fine, and weigh not less than 112 lbs. to the imperial bushel; samples of it to bear a tensile load of not less than 350 lbs. per square inch of section after seven days' immersion in water. All exposed joints of the brickwork are specified to be neatly pointed and drawn in with a ¼-in. key. The concrete is composed of one part of Portland cement (of the same quality as above), one part of clean sharp sand, and five parts of hard stones or bricks broken to pass through a 2-in. ring. The cast-iron work, made of tough Scotch gray iron, is required to bear a tensile stress of 6½ tons per sq. in. of section before fracture and 2½ tons per sq. in. without loss of elasticity, while a bar 1 in. sq. is to sustain a weight of 7 cwt. at the center of a 3-ft. span. All castings are to be sound, clean, free from cinder, air-holes, twists, and all similar blemishes, and to have a skin perfectly smooth and uniform. The malleable iron is specified not to fracture with a less load than 22 tons per sq. in. of sectional area, with an elongation before fracture of not less than 8 per cent. on a length of 10 in. The iron work is dipped in a mixture of boiling tar and pitch, and all exposed parts receive two coats of Carson's patent anti-corrosive white paint.

The work of riveting up the second shield at the bottom of the shaft on the south side will shortly be commenced, while the erection of air-compressing plant and boiler power for the same on the surface is completed.

## THE UNITED STATES NAVY.

The Navy Department has devoted considerable attention recently to the armor for the new ships, and experiments have continued at the new Indian Head proving ground on the Potomac. In the latest trials two targets were made up, one composed of two 1½-in. plain steel plates, and the other of two plates of the same thickness of nickel steel. They were intended to represent a protective deck, and in these trials were placed almost horizontally, presenting an angle of 2° only to the line of fire. The gun used was a 6-in. breech-loading rifle with a 100-lbs. armor-piercing projectile. With a muzzle velocity of 1,780 foot-seconds, the shots passed through both of the plain steel plates, through 2 ft. of oak backing and 8 ft. of earth. With the nickel-steel plates, on the other hand, the shot had a velocity of 1,873 foot-seconds, and its only effects on the target were a small crack 5 in. long in one plate and an indentation from 3 to 5 in. deep. The shot itself was broken in pieces.

The tests of nickel-steel and of the Harvey process have been so successful that the Navy Department has given an order for nickel-steel armor plates for the 13-in. side armor for the coast defense ship *Monterey*, now building in San Francisco. The turret armor for this ship, which is now being made at Bethlehem, and which is of plain steel, will also be treated by the Harvey process.

The new 6-in. rifle built at the Washington Navy Yard has given some excellent results under test. This is the longest 6-in. gun yet made by the Navy, having a length of 40 calibers. With this gun a velocity of 2,180 foot-seconds has been attained without exceeding an internal pressure of 15 tons to the square inch.

Trials have been made of the first samples of smokeless powder for the Navy Department with very good success. These trials were made with 6-pounder and 3-pounder rapid-fire guns. The powder has been made by Professor Munroe, chemist at the torpedo station at Newport, and its composition has not been made public.

The Washington Ordnance Shop has completed the first of the 4-in. and 5-in. rapid-fire guns. The 4-in. gun is designed for a muzzle velocity of 2,000 ft., with a projectile weighing 33 lbs. and a charge of 12 to 14 lbs. This gun has a bore of 128 in. There are 30 grooves in the rifling. The total length of the piece is 13.7 ft., and its weight 1½ tons. The 5-in. gun weighs 3.1 tons, and is 17.4 ft. long over all. It is expected to attain a muzzle velocity of 2,250 ft., with a shot weighing 168 lbs. and a charge of 30 lbs. of powder. The mount for these guns is that designed by Lieutenant Fletcher, and is of the same type which has been used for similar rapid-fire guns.

### NEW SHIPS.

The next ship to be launched for the Navy will probably be Cruiser No. 9, which has been named *North Point*, and which is under construction at the Columbian Iron Works, in Baltimore. This ship and No. 10, which is at the same yard, are 257 ft. long, 37 ft. beam, 14 ft. 6 in. mean draft and 2,000 tons displacement. They are to have a speed of 18 knots, will be armed with rapid-fire guns, and will doubtless be very useful ships.

Bids were opened August 26 for the construction of torpedo-boat No. 2, a description of which has already been published. This is to have a maximum speed of 25 knots an hour guaranteed by the contractor. Two bids only were received. The Cowles Engineering Company, of Brooklyn, N. Y., offered to build the ship for $117,490, while the Iowa Iron Works, of Dubuque, Ia., presented a bid for $113,500. It is probable that the contract will be awarded to the last-named company, as a report has been made to the Navy Department, after inspection, that it possesses sufficient facilities for executing the contract properly, and within the required time.

## A LONG COMPARATOR.

By Professor J. Howard Gore.

We are a nation of boasters, addicted to a chronic use of superlative adjectives. It is our pleasure to speak of the tallest monument, the longest bridge, the greatest lakes and rivers, etc., and we reach our climax of joy when we add "in the world." After the perusal of this article some may feel that there is now one thing more to be placed in the superlative class—the longest *Comparator* in the world. The Coast Survey several years ago laid out and marked near Washington a kilometer which was to have the name "standard kilometer," but it has never been standardized. Likewise the Prussian Geodetic Institute has projected a kilometer near its new building at Potsdam, but the expectation is that this will be regarded merely as a test base where various forms of apparatus can be tried. But the hectometer at the Holton base-line is in the strictest sense of the word a comparator, and one of the highest degree of merit.

At each end of the stretch heavy rectangular stone pillars were set on top of a broad foundation which were placed on a base of cement. The tops of these stones are even with the surface of the ground, and are provided with brass bolts whose upper ends terminate in carefully turned hemispheres. These bolts are firmly imbedded in the stones, and project far enough above the stones to admit of caps, which are screwed over the hemispheres for their protection. These spheres are not marked, but serve as the support of what is called a cut-off—such as was used by the Lake Survey with such marked success. In the main a cut-off consists of a steel tube, the lower end furnished with a socket which fits the brass hemisphere just mentioned; the other end carries a level and scale fixed at right angles to its axis. This scale is accurately divided into millimeters, the zero point being in the axis of the steel tube. It is apparent that when the level, in adjustment, indicates horizontality, the zero point of the scale is

directly over the center of the sphere on which the tube rests. If the graduation of the scale is eccentric, the error is eliminated by reversing the scale—that is, by turning the tube through 180° in azimuth. The tube has a rack so constructed that the upper end can be thrust upward, thus carrying the scale into the focus of a reading microscope. With the ends of the comparator in the axes of the cut-offs—one at each end—the question remains, how to determine the *exact* distance between these verticals. A double track resting on broad stringers spiked to 4-in. × 12-in. posts well set in the ground extends from one end of the comparator to the other, with the terminal stones approximately midway between the two tracks, but completely isolated from them. Opposite these stones, and near, but not touching the track, are 6-in. × 6-in. posts projecting about 19 in. above the track; similar posts are likewise placed in the line of these two along the whole length at a distance of 5 meters apart. They are supports for reading microscopes.

The only feature that remains to be described is the bar and its application to the comparator. The bar is of steel, with silver plugs set in its neutral axis, on whose upper surfaces a fine line on each marks the terminus of the 5 meters. This bar rests in the vertical of its greater transverse section in a steel Y-shaped trough. The trough itself is carried on two trucks of three wheels each so distributed as to run smoothly on the iron rails of the track already described. By means of screws the supports of the trough can be moved transversely in the direction of its length, and up or down.

Before leaving Washington the bar was most carefully compared with the committee's meter, both being surrounded by ice, so that the distance between the lines on the plugs is known at this temperature. In obtaining the length of the comparator, the operation in general is as follows: The cut-off is placed in position and leveled, a reading microscope provided with a micrometer reading to tenths of a mikron, is pointed on a convenient division of the scale, and read both before and after reversal, together with contemporaneous level readings; the cut-off is removed, and the carriage bearing the bar surrounded by fine ice is rolled along until its rear end is brought under and in the focus of the microscope just used, a pointing is made on the terminal line within the nearest revolution of the micrometer and the division recorded; while this is being done a similar microscope is read on the forward end of the bar. The bar is then wheeled along until the rear end occupies a position with respect to the second microscope that it just had with respect to the first, and the microscope vacated is carried forward and clamped to a post ready for future use; with four of these microscopes there is ample time for one to become steady before being used. From this it is seen that each forward microscope is made to fix and hold the exact point reached by a length of the bar. When the other end of the comparator is reached, an operation approximately the converse of the one first described is performed, that is, the pointing is first made on the bar, and that point determined with respect to the center of the sphere by readings on the cut-off. These operations, somewhat complex in their description, are, however, so readily performed that the twenty applications necessary for measuring the hectometer can be made in about half an hour.

THE HOLTON COMPARATOR.

SHOWING APPLICATION OF SECONDARY BARS TO THE COMPARATOR.

Every possible care has been taken to secure stability in the track, stones, and microscopes, and by way of precaution the walks on both sides of the track are covered with sawdust, and the whole is roofed in and enclosed on one side and both ends. Its east and west direction protects all parts of the apparatus from sudden changes of temperature due to sunshine and clouds.

From a number of measurements of the comparator the probable error of its length has been found to be equivalent to one part in five millions, which is approximately the same as the error of comparing the five-meter bar with the prototype, so that we may say the length of the comparator is absolutely known in terms of the international standard.

On this comparator the apparatus used in measuring the Holton base has been tested with most satisfactory results. Likewise the tapes to be employed in the same work have had their lengths determined here, and also their coefficients of expansion.

The discussion of the observations made at Holton will contain most interesting facts regarding the behavior of

metals at different temperatures, the effects of tension on length, and the possibilities of tapes for base measuring.

The accompanying illustration, from a photograph, shows the application of secondary bars to the comparator. From this and the description above, the method of operation can be readily understood.

## THE WOOTTEN LOCOMOTIVE.

THE report of the Committee on Science and the Arts of the Franklin Institute, awarding the John Scott premium and medal to Mr. John E. Wootten, for his invention of a locomotive boiler, has been recently published in the *Journal* of the Franklin Institute, and to it we are indebted for the following account, which includes the substance of the report :

The distinguishing features of these engines, as compared with others, is a much greater breadth of furnace and larger area of grate, with a less depth of fuel thereon, a change in the location of the cab from the rear of the engine and at the sides of the fire-box to a position above the furnace, in some instances, and in others on each side of the waist of the boiler immediately in front of the fire-box, the steam-dome being located in the cab.

The construction of frames, driving-wheels, cylinders and steam-chests is not strikingly different from other well-known and usual types of engines.

This engine has been gradually developed into its present form ; at the outset, a demand, constantly increasing, for cheaper freights and diminished expense for motive-power in drawing trains, compelled the use of trains of greater capacity, so as to reduce the cost of wages relatively to the tonnage hauled. This necessitated more powerful engines ; and while it was not difficult to increase the cylinder capacity or piston displacement of the engines, the limit of the boiler to supply adequate steam to such engines was soon reached.

The gauge of the railroad appeared to limit the width of the boilers admissible, the frames could not be spread any further apart, and under the practice of placing the furnace of the boiler between the frames, the only increase of grate surface practicable was in the direction of length. This rendered firing more difficult, and a deep bed of fuel was required to maintain steam pressure, the draft of air to maintain combustion demanded greater pressure on the exhaust, which could only be enforced by contracting the nozzle of the exhaust pipe and imposing a pressure upon the steam pistons during the return strokes. This, in view of the large piston surface recently coming into vogue, especially in compound locomotives, means a serious waste of force.

In addition to the above incentives to improvement, immense quantities of perfectly good coal, in dust and small grains, was steadily accumulating around every mine, and while its value, when burned in a well-adapted furnace in a stationary engine, was a matter of daily demonstration, no long furnace or deep bed of such fuel was able to burn it upon a railroad locomotive ; and, moreover, a deep fire of such fuel would not burn because the draft could not be forced through its entire surface without much of the fuel being carried beyond reach with the then generally adopted furnaces.

The solution of this difficulty was found in an increased breadth of furnace, grate and fire-box to accommodate it. Space to contain such boilers without interfering with the driving-wheels was procured by placing the boiler above the driving-wheels and frames, which were protected from ashes by a hopper-shaped ash-pit.

The boiler then had broad expanses of nearly flat metallic external as well as internal surfaces, having cross-seams exposed to high internal pressure and required to be securely stayed or braced. The form of the plates presented oblique opposing surfaces, and stay-bolts diagonal to such surfaces were applied to hold them together.

The oblique strain upon such stays and the oblique intersections of the stays and plates were subjected to shearing or diagonal strains, and the failure of such stays by breaking close to the plates became a conspicuous objection to such structures.

The remedy was found in changing the form of the furnace and the portion of the external shell of the boiler enclosing it so as to bring nearly parallel surfaces, formed of large plates without cross-seams, opposed to each other. After this the stays uniting them were subjected only to direct tensile strains, and withstood them.

The fuel in such broad expanses of surface developed volumes of combustible gas, which burned with best effect when in large body or volume, but only imperfectly when subdivided by entering the flue tubes ; so a combustion chamber was added.

The volume of draft usual with large fuel when applied to fine or pulverulent fuel on a small grate surface, lifts and carries much of it mechanically from the furnace, but in the broad expanses of grate furnished in this boiler, the same volume passes through at a lower velocity and with less pressure, so that instead of sweeping particles of fuel through the tubes with the products of combustion, the fine ash only appears to pass and deposit in a flocculent state in the smoke-box and chimney.

The changes in form of the boiler, which we have thus far noted, are with reference to the combustion of fuel and generation of heat and durability of the boiler.

From experience it appeared desirable to place as much of the weight of the boiler as practicable lower down.

This was effected by the partition or bridge, excluding the fuel from the combustion chamber, in the shape of a dam, with the flue tubes and waist lower down in relation to the grate surface.

The combined effect of these improvements can best be understood by the report of the engine as worked upon the roads.

A sufficient proportion of the weight of the engine is placed upon the front truck wheels, serving to guide it securely upon the rails, while as large a proportion as is practicable is utilized in compelling adhesion between the driving-wheels and the rails for purposes of propulsion.

A capacity for burning fuel, impracticable in furnaces of small grate area and large depth of fire-bed, and an economy in quantity as well as quality of fuel required, ensued.

The several stages of improvement are set forth in the letters-patent, and a brief notice of their features is here briefly stated in chronological order.

In letters-patent 192,725, of July 3, 1877, the hopper-shaped ash-pit and fire-box extending sidewise over the rear driving-wheels of one engine with six drivers and four truck wheels is shown, the combustion chamber being over the middle driving-wheel axle, and included in a tapering part of the boiler uniting the fire-box portion with the cylindrical waist. The claim of this patent is for a fire-box wider than the distance between the wheels, and for the combustion chamber in combination with a bridge wall.

In letters-patent No. 254,581, of March 7, 1882, the ash-pit is in the form of two rectangular funnels or hoppers, the grate is inclined from rear downwardly to the front, a flat crown-sheet is used, stayed with parallel vertical stays to the outer curved shell, and the proportion of the combustion chamber in length to the furnace chamber is reduced.

In letters-patent 291,120, dated January 1, 1884, the forward part of the grate immediately in the rear of the bridge wall and across the entire width of the fire-box is covered with fire-brick to receive small particles of fuel which the draft through the grate would otherwise sweep over the bridge wall.

Patent No. 352,215, of November 9, 1886, shows an improved form of bridge wall which practically separates a combustion chamber within the fire-box from the fuel supporting space on the grate.

Patent No. 354,370, of December 14, 1886, is for a construction of boiler in which the rearward flue-sheet of the furnace is without perforations, and acts as a bridge wall dispensing with the separate bridge walls in the preceding forms of this boiler.

Patent No. 361,661, of April 19, 1887, to J. F. Wootten and J. Snowden Bell, is for a form of this boiler in which

a central partition or water-wall is introduced in the furnace, making in effect two furnaces, with a bridge wall

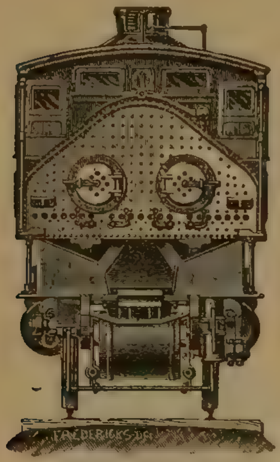


Fig. 2.

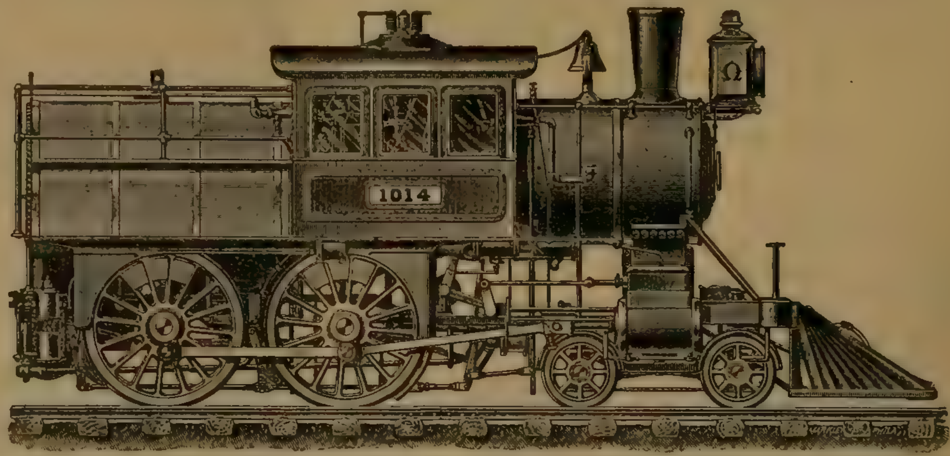


Fig. 1.

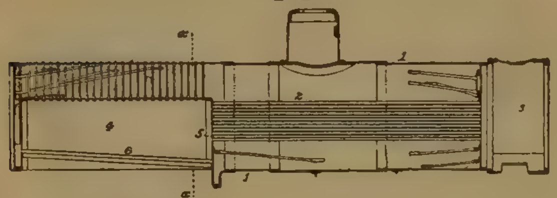
LOCOMOTIVE WITH WOOTTEN BOILER.

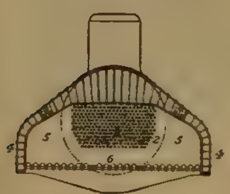
between the furnaces and the combustion chamber and flue.

This construction offers the advantages of alternate firing, so that the gases from the fresh fuel in one furnace can meet the intensely heated flames and products of combustion from the other furnace, and produce a better combustion.

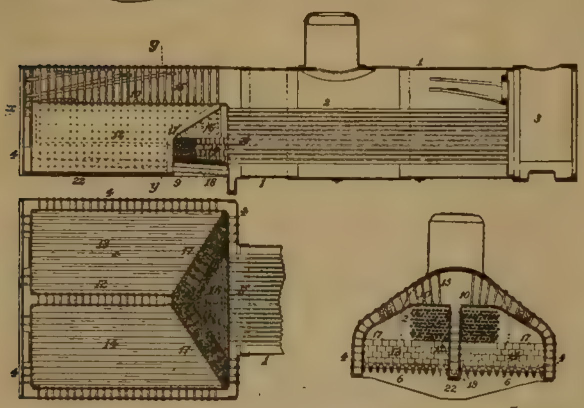
The effect of these improvements, which it will be seen

Fig. 3.





Patent No. 354,370, December 14, 1886.



Patent No. 361,661, April 19, 1887.

Fig. 4.

are in a continuous line of gradual development, are to produce a most efficient and serviceable boiler, capable of economically burning cheap grades of fuel inadmissible in other kinds of locomotive boilers.

In support of their conclusions, the Committee quote from the report of tests made by Dr. C. M. Cresson, of a Wootten boiler and an ordinary locomotive boiler burning several kinds of fuel. The results of these tests may be summed up briefly as follows, the table giving the percentage of the total heat units in the fuel used actually utilized in each case :

| Class of Locomotive. | Kind of Coal. | Per cent. of total heat utilized. Wootten Boiler. | Per cent. of total heat utilized. Ordinary Boiler. |
|---|---|---|---|
| Consolidation freight... | Anthracite, waste. | 69.4 | .... |
| Passenger... .......... | Anthracite, marketable. | 65.5 | 50.0 |
| Consolidation freight... | Bituminous, waste. | 64.3 | .... |
| Consolidation freight... | Bituminous, marketable. | 69.4 | 55.2 |
| Passenger.............. | Bituminous, marketable. | 68.3 | 54.0 |
| Consolidation freight.. | Lignite, 20 per cent. water. | 42.1 | .... |

The data from which the work done by these fuels is derived were obtained from the results of continuous daily operations, of such magnitude as to remove them from the category of experiment and place them upon the footing of practical operations.

The award of the Committee was therefore made by the excellent results shown by this invention under tests, fully confirmed by several years of practical use.

The illustrations given herewith show, in figs. 1 and 2, an elevation and rear view of a locomotive with Wootten boiler; in figs. 3 and 4, respectively, the patents No. 354,370 and No. 361,661, as described above.

## THE FOWLER TUBULAR BOILER.

THE accompanying illustration, from *Industries*, shows a boiler devised by W. H. Fowler, of Manchester, England. Fig. 1 is a vertical section and fig. 2 a horizontal section.

The inventor claims for this boiler that it is a quick steam raiser, easy of access for cleaning and repairs, and simple in construction. Referring to fig. 1 it will be seen that the fire-box is conical in section, and is riveted at the upper end to a plain cylinder, divided midway into two portions by a fire-clay partition carried on a ring of angle iron supported by brackets. The flame and heated gases, after passing through the lower set of tubes into the smoke-box, pass thence through the upper tubes to the combustion chamber, which is in direct communication with the uptake. It will be seen from the engravings that there is a complete absence of cross water pipes or other

obstructions in the fire-box, and also that there is no awkward flanging. The circular form is adhered to throughout, and the annular arrangement of parts permits easy inspection. The fire-box being circular, an easily made flange joint is used for uniting the ring seams. Where

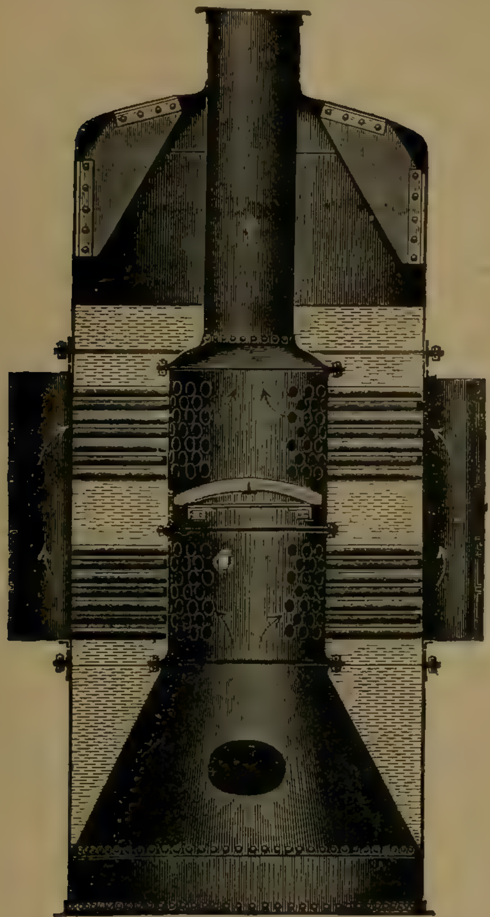


Fig. 1.—Vertical Section.

Fig. 2—Sectional Plan.

THE FOWLER BOILER.

necessary, the boiler can be divided into three sections for convenience in transportation, and the two bolted joints can easily be made.

The construction can be modified for small boilers, so that the smoke-tubes can discharge directly into an external smoke-box connected with the uptake, instead of being returned to a central uptake, as in the boiler shown in the illustration.

## PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

Having, in June, 1890, delivered a lecture, since published in the Railroad and Engineering Journal, on the general subject of "Aerial Navigation," in which a sketch was given of what has been accomplished with balloons, I propose in the present paper to treat of Flying Machines proper—that is to say, of forms of apparatus heavier than the air which they displace; deriving their support from and progressing through the air, like the birds, by purely dynamical means.

It is intended to give sketches of many machines, and to attempt to criticise them.

We know comparatively so little of the laws and principles which govern air resistances and reactions, and the subject will be so novel to most readers, that it would be difficult to follow the more rational plan of first laying down the general principles, to serve as a basis for discussing past attempts to effect artificial flight. The course will therefore be adopted of first stating a few general considerations and laws, and of postponing the statement of others until the discussion of some machines and past failures permits of showing at once the application of the principles.

The first inquiry in the mind of the reader will probably be as to whether we know just how birds fly and what power they consume. The answer must, unfortunately, be that we as yet know very little about it. Here is a phenomenon going on daily under our eyes, and it has not been reduced to the sway of mathematical law.

There has been controversy not only about the power required, but about the principle or method in which support is derived. The earlier idea, now abandoned, so far as large birds are concerned, was that when they flapped their wings downward they produced thereby a reacting air pressure wholly equal to their weight, and so obtained their support. This is known as the "orthogonal theory," and has been disproved by calculations of the velocity and resulting pressures of the wing beats of large birds, and by the more recent labors of Professor Marey. It seems likely that the smaller birds, who, as will be explained hereafter, are probably stronger in proportion to their weight than the larger birds, possess the power of delivering blows upon the air equal to a supporting reaction. Such may be the case in the hovering of the humming-bird and the rising vertically of the sparrow; but the latter exertion is evidently severe, and cannot be long continued.

Mr. Drzeweicki has shown that a buzzard, beating his wings $2\frac{1}{2}$ times a second, with an amplitude of 120°, could only obtain, according to accepted formulæ of air pressures, a sustaining orthogonal reaction of 0.40 pounds or about $\frac{1}{10}$ of his weight, while if his wings are considered as inclined planes, progressing horizontally at a speed of 45 miles per hour, a sustaining reaction is easily figured out.

It seems quite certain that large birds cannot practice orthogonal flight, and that they derive their support mainly if not wholly from the upward reaction or vertical component of the normal air pressure due to their speed. That they are living Aeroplanes, under whose inclined wings their velocity creates a pressure which is normal to the surface. This is confirmed by the great difficulty which they experience in getting under way. They run against the wind before springing into the air, or preferably drop down from a perch in order to gain that velocity without which they cannot obtain support from the air. Thus the surfaces of their wings act as aeroplanes as well as propellers, the latter action being produced by the direction of the stroke and the bending upward of the rear flexible portion of the feathers.

Bird flight may be considered as comprising three phases:

1. Starting, during which great exertion must be made, unless gravity can be utilized.

2. Sailing, or flight proper, during which the bird exerts his normal force, or makes use of that of the wind, as will be more particularly explained hereafter.

3. Stopping, in which great exertion may again be re-

quired, if the headway is to be rapidly stopped, or in which the retarding force of gravity may be brought to do the work by simply rising to a perch.

Artificial flying machines will certainly have to conform to these three phases of flight, by providing methods of starting and stopping in addition to the means for performing the act of flight proper.

Birds perform all their manœuvers by regulating the intensity of their action, and by changing the angles at which they attack the air. Hence the important thing for us to know is to ascertain what pressure exists under a wing or, to simplify the question, under a plane surface, when it meets the air at a certain velocity and with a certain angle of incidence.

This has been, until the recent publication of Professor Langley's most important labors, a subject of uncertainty, which uncertainty he has done much to remove. We had had glimpses of the law; but notwithstanding very many experiments by physicists, its numerical values were a subject of doubt and controversy among the few who gave any attention to the subject. It was the missing link, which rendered nearly unavailable the little that was known in other directions.

By the law of fluid reactions all air pressures are "normal," or exerted perpendicularly to the surfaces against which they bear; now the question was: What is the relation between the pressure of a current of air of known velocity against a thin plane surface placed at right angles thereto, and the normal pressure of that same current against the same plane, if the latter be inclined to the current at an angle of incidence less than 90 degrees?

Newton impliedly gave a solution; but experiments long ago proved it to be wrong, although it is still taught in the schools and given in formulas in engineering reference books. He assumed, plausibly enough, that the proportional normal pressure was in the ratio of the sine of the angle of incidence, and when experiment showed this to be erroneous, other formulas were proposed, the following being a few of those which have been wrangled over:

Calling $a$ the angle, and $P$ the pressure on the inclined surface, while $P'$ is that upon the right-angled surface, the following were assumed to represent the relation:

$$P = P' \sin a \qquad P = P' \sin^2 a$$

$$P = P' \sin^3 a$$

$$P = P' \frac{2 \sin a}{1 + \sin^2 a} \qquad P = P' (\sin a)^{1.84 \cos a}$$

$$P = 2 P' \sin a$$

Indeed, the field seemed so open in this direction that only two years ago I ventured to propose a formula of my own, which I subsequently concluded to be erroneous; but the question seems now to be set at rest for the present by the experiments of Professor Langley, who proposes no formula of his own, but who shows that his results approximate very closely to the formula of Duchemin:

$$P = P' \frac{2 \sin a}{1 + \sin^2 a}$$

I had already independently reached a conclusion quite similar. Finding that my formula was incorrect, I had a chart plotted, on which were delineated all the experiments on inclined surfaces which I could learn about—those of Hutton, Vince, Thibault, Duchemin, De Louvrié, Skye, the British Aeronautical Society, and W. H. Dines; and on this chart I also had plotted the curves of the various formulas. The whole exhibited great discrepancies, yet by patient analysis various probable sources of error were eliminated, and the conclusion was reached that the formula last given, which I have seen variously attributed to Bossut or to Duchemin, was probably correct.

From this formula I had computed for my own use the accompanying table of normal pressures; and as it seems to be quite confirmed by Professor Langley's experiments, and seems to promise to be of great use, I now venture to publish it.

Once the normal pressure is known at a particular angle of incidence, its static components in different directions can be obtained by the laws governing the resolutions of forces. This was shown, as early as 1809, by Sir George Cayley, in the following demonstration, in which he ingeniously evades the then prevailing confusion about the "law of the angle" by starting with the weight of the bird instead of its wing surface and velocity. He says:

APPROXIMATE PERCENTAGES OF NORMAL PRESSURE. DERIVED FROM CHART OF EXPERIMENTS AND THEORIES. CALCULATED BY BOSSUT'S OR DUCHEMIN'S FORMULA.

$$P = P' \frac{2 \sin a}{1 + \sin^2 a}$$

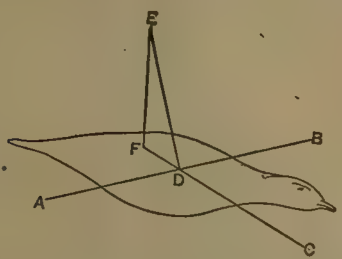
| Deg. of Angle. | Results of S. P. Langley's Experiments. | Proportion Normal Pressure. | Lift. | Drift. |
|---|---|---|---|---|
| 1 | | 0.035 | 0.035 | 0.000611 |
| 1½ | | 0.052 | 0.052 | 0.00136 |
| 2 | | 0.070 | 0.070 | 0.00244 |
| 3 | | 0.104 | 0.104 | 0.00543 |
| 4 | | 0.139 | 0.139 | 0.0097 |
| 5 | 0.15 | 0.174 | 0.173 | 0.0152 |
| 6 | | 0.207 | 0.206 | 0.0217 |
| 7 | | 0.240 | 0.238 | 0.0293 |
| 8 | | 0.273 | 0.270 | 0.0381 |
| 9 | | 0.305 | 0.300 | 0.0477 |
| 10 | 0.30 | 0.337 | 0.332 | 0.0585 |
| 11 | | 0.369 | 0.362 | 0.0702 |
| 12 | | 0.398 | 0.390 | 0.0828 |
| 13 | | 0.431 | 0.419 | 0.0971 |
| 14 | | 0.457 | 0.443 | 0.1155 |
| 15 | 0.46 | 0.486 | 0.468 | 0.124 |
| 16 | | 0.512 | 0.492 | 0.141 |
| 17 | | 0.538 | 0.515 | 0.157 |
| 18 | | 0.565 | 0.538 | 0.172 |
| 19 | | 0.589 | 0.556 | 0.192 |
| 20 | 0.60 | 0.613 | 0.575 | 0.210 |
| 21 | | 0.637 | 0.594 | 0.228 |
| 22 | | 0.657 | 0.608 | 0.246 |
| 23 | | 0.678 | 0.623 | 0.264 |
| 24 | | 0.700 | 0.639 | 0.286 |
| 25 | 0.71 | 0.718 | 0.650 | 0.304 |
| 26 | | 0.737 | 0.662 | 0.323 |
| 27 | | 0.752 | 0.670 | 0.342 |
| 28 | | 0.771 | 0.681 | 0.362 |
| 29 | | 0.786 | 0.686 | 0.382 |
| 30 | 0.78 | 0.800 | 0.693 | 0.400 |
| 31 | | 0.815 | 0.698 | 0.421 |
| 32 | | 0.828 | 0.702 | 0.439 |
| 33 | | 0.843 | 0.706 | 0.459 |
| 34 | | 0.853 | 0.707 | 0.478 |
| 35 | 0.84 | 0.867 | 0.708 | 0.498 |
| 36 | | 0.878 | 0.709 | 0.516 |
| 37 | | 0.885 | 0.709 | 0.532 |
| 38 | | 0.894 | 0.705 | 0.551 |
| 39 | | 0.902 | 0.701 | 0.569 |
| 40 | 0.89 | 0.910 | 0.697 | 0.586 |
| 41 | | 0.918 | 0.693 | 0.602 |
| 42 | | 0.926 | 0.688 | 0.619 |
| 43 | | 0.934 | 0.683 | 0.638 |
| 44 | | 0.941 | 0.676 | 0.654 |
| 45 | 0.93 | 0.945 | 0.666 | 0.666 |

When large birds, that have a considerable extent of wing compared with their weight, have acquired their full velocity, it may frequently be observed that they extend their wings, and, without waving them, continue to skim for some time in a horizontal path.

Fig. 1 represents a bird in this act. Let $A$ $B$ be a section of the plane of both wings, opposing the horizontal current of air (created by its own motion), which may be represented by the line $C$ $D$, and is the measure of the velocity of the bird. The angle $B$ $D$ $C$ can be increased at the will of the bird, and to preserve a perfectly horizontal path, without the wing being

waved, must continually be increased in a complete ratio (useless at present to enter into), till the motion is stopped altogether; but at one given time the position of the wings may be truly represented by the angle $B\ D\ C$. Draw $D\ E$ perpendicular to the plane of the wings, produce the line $C\ D$ as far as required, and from the point $E$, assumed at pleasure in the line $D\ E$, let fall $E\ F$ perpendicular to $D\ F$; then $D\ E$ will repre-

Fig. 1.




sent the whole force of the air under the wing—*i.e.*, normal pressure, which being resolved into the two forces $E\ F$ and $F\ D$, the former represents the force that sustains the weight of the bird, and the latter the retarding force by which the velocity of the motion producing the current $C\ D$ will be continually diminished; $E\ F$ is always a known quantity, being equal to the weight of the bird, and hence $F\ D$ is also known, as it will bear the same proportion to the weight of the bird as the *sine* of the angle $B\ D\ C$ bears to its *cosine*, the angles $D\ E\ F$ and $B\ D\ C$ being equal.

In the table herewith given, the first column shows the degree of the angle of incidence; the second the result of Professor Langley's experiments; the third the proportion or percentage which the normal pressure at that angle bears to the pressure at the same velocity of the same plane at right angles to the current; while the fifth and sixth columns show the resolutions of this normal pressure, being the force which sustains the weight of the bird vertically as against gravity, which is here termed the "Lift;" and the retarding force against horizontal motion, which is here termed the "Drift." They are calculated by multiplying the normal pressure by the *sine* and by the *cosine* of the angle.

In order to obtain the aggregate normal pressure, or the lift and the drift, upon any thin plane surface, it is simply necessary to multiply its area by the pressures per square foot, which are given (approximately) in the ordinary tables of wind velocities, and this again by the percentages given in the table.

The angles are only given up to 45°, as more than this would be useless to the general reader; and it will be noted that there is an angle of maximum uplift at about 36°. This results from the fact that the normal pressure is continually increasing, while the *cosine* of the angle is continually diminishing, but not equally, so that their product reaches a maximum, as stated. This is confirmed by the results of Professor Langley's experiments, as recorded on page 58 of his "Experiments in Aerodynamics."

It should be borne in mind that the table only purports to apply to thin planes one foot square, and hence is given as containing only approximate percentages of normal pressures. For other shaped planes, for curved surfaces, and for solids the percentages may be different, because a great many anomalies have been found in experimenting upon air resistances, and we yet know painfully little about them.

For instance, the following may be mentioned:

1. For high velocities, such as those of projectiles, the resistances do not vary as the square of the speed, as assumed in ordinary tables; they more nearly approach the cube of the velocity.

2. If a thin plane be exposed to a current of air, at right angles thereto, the pressure on the plane is not uniform over all its surface, but is greatest at the center.

3. Plane surfaces of equal areas but of different shapes (square, oblong, triangular, etc.) are found to receive slightly different pressures at the same speed. Moreover, the average pressure per square foot varies with mere variation of size on the same shaped planes.

4. The pressure upon an inclined elongated surface will vary for the same speed, whether it be exposed longitudinally or transversely to the current.

5. Holes may be cut in thin planes without reducing the aggregate pressure in proportion to the surface cut away. Moreover, the aggregate pressure may be made to vary by simply changing the position of the holes.

6. Inclined planes may be superposed without diminishing the sum of their separate individual pressures, provided they are properly spaced with regard to the angle of incidence. If too close, they will interfere with each other, but the amount of such interference will vary with the speed.

7. Perfectly horizontal planes, free to fall, have their time of falling much retarded if in rapid horizontal translation.

8. The weight remaining the same, the force requisite to sustain *inclined* planes in horizontal motion diminishes instead of increasing, when the velocity is augmented.

9. If the plane be gradually inclined to the current, the point of maximum pressure will move forward toward the front edge as the angle of incidence diminishes. The position as given by Joëssel's law is shown by the formula:

$$C = (0.2 + 0.3 \sin a)\ L,$$

in which $C$ represents the position of the center of pressure, $L$ the length, and $a$ the angle of incidence, the formula indicating that the position of the center of pressure varies from 0.5 to 0.2 of the distance from the front to the center of the plane.

Of these anomalies, the 6th, 7th and 8th were experimentally determined by Professor Langley; and he partly confirmed the 9th, as well as giving strong confirmation to the results of Duchemin on the "law of the angle" previously mentioned. The 8th is especially important, and its consequences are pointed out by Mr. Langley in the following words:

> The most important general inference from these experiments, as a whole, is that, so far as the mere power to sustain heavy bodies in the air by mechanical flight goes, such mechanical flight is possible with engines we now possess, since effective steam-engines have lately been built weighing less than 10 lbs. to 1 H.P., and the experiments show that if we multiply the small planes which have been actually used, or assume a larger plane to have approximately the properties of similar small ones, 1 H.P., rightly applied, can sustain over 200 lbs. in the air, at a horizontal velocity of over 20 meters per second (about 45 miles an hour), and still more at still higher velocities.

These general remarks chiefly apply to thin plane surfaces, such as might be used in flying machines, but mere thickness plays an important part; for in a solid body, with the same area of exposed head surface, the pressure will be varied by the depth, and especially by the form of the body in the rear. Thus curved surfaces and solids have quite different coefficients of pressure from thin flat planes, and theoretical estimates of their resistances have hitherto proved to be quite wrong.

Indeed, it may be said with respect to curved surfaces and solids, that a glimpse has been caught of a still more mysterious phenomenon. It is known that certain shapes, when exposed to currents of air under certain ill-understood circumstances, actually move toward that current instead of away from it. Thus a hollow sphere impinged upon by an air jet will move up toward it instead of away. The lower disk in Professor Willis's apparatus, when blown upon, moves against the current toward the upper disk. Dr. Thomas Young proved, in 1800, that a certain curved surface suspended by a thread approached an impinging air current, instead of receding from it. M. Goupil found, in experimenting, that a suspended hollow shape was first blown out to a horizontal position by a wind of sufficient velocity, and then, when that velocity increased, actually drew into the wind for an instant and slackened the tension on the cord. It is also said that certain forms of windmills wear more on the front stop than on the back stop of their axle of rotation; so that there seems to be a mysterious action, which some French observers, who have been watching birds soar, have, for want of a better term, called their "Aspiration," by which a body acted upon by a current may actually draw forward into that current against its direction of motion.

BATTLE-SHIP "HOCHE" FOR THE FRENCH NAVY.

Thus it is seen that in such complicated matters theory cannot progress in advance of experiment, and the extreme importance of those experiments hitherto tried, or hereafter to be tried by a physicist possessing the ability of Professor Langley, will in part be appreciated.

Science has been awaiting the great physicist, who, like Galileo or Newton, should bring order out of chaos in aerodynamics, and reduce its many anomalies to the rule of harmonious law. It is not impossible that when that law is formulated all the discrepancies and apparent anomalies which now appear, will be found easily explained and accounted for by one simple general cause, which has been hitherto overlooked.

Thus far, Professor Langley seems to have experimented upon plane surfaces only, and to have measured chiefly what has been termed in the table here given the "lift" and the "drift" at various angles. His conclusions therefrom are very important; but the "drift" will not be the sole resistance to be encountered, for the sustaining surfaces of a flying machine must not only have a certain thickness, to give them the necessary strength and rigidity, but there will be friction of air upon them, and there must be a solid body or hull to contain the machinery and the cargo.

Thus the elements of resistance are three in number:

1. The hull resistance.
2. The drift.
3. The skin friction.

Of the skin friction Professor Langley says that it is apparently so small that it may be neglected without material error; and he has given the measure of the "drift" as the result of his experiments.

The head or hull resistance will probably be found to be the chief element which will limit the possible speed of flying machines. It will probably grow as the square of the velocity, thus requiring the power exerted to vary as the cube of the speed, but will be modified by a series of coefficients, due to the shape of the solid body, just as some birds are swifter flyers than others of the same weight, in consequence of their difference in shape.

Hence the power required to drive such a machine can only be approximated at present; but this will be more particularly discussed when treating of the areas of supporting surfaces and speed of birds, for the reader may be impatient to be told something of what has been attempted by man.

Inventors, in their ignorance of the laws of air reactions and resistances, have proposed all sorts of devices for compassing artificial flight and experimented with not a few; so that Mr. E. Dieuaide, of Paris, upon making a study of the subject, published in 1880 an illustrated chart,* in which he delineated the more remarkable machines which had been proposed for aerial navigation without the use of balloons. This chart contains some 53 figures; and from this, as well as from the book of M. Gaston Tissandier on aerial navigation,† which contains much accurate information, the following has been chiefly compiled, in which it will be attempted not only to give an account of what has been proposed, so far as the meager data will permit, but also to critcise the machines with the light of our present knowledge, and to endeavor to point out why they failed. Failures, it is said, are more instructive than successes; and thus far in flying machines there have been nothing but failures.

These various machines, diverse as they are, may roughly be classed under the three following heads, according to the intentions and theories which were held by their authors, as to the most efficacious way of deriving support from the air.

A. Wings and parachutes.
B. Screws to lift and propel.
C. Aeroplanes.

(TO BE CONTINUED.)

* *Tableau d'Aviation.* Représentant tout ce qui a été fait de remarquable sur la navigation Aérienne sans Ballons. Published by the author.

† *La Navigation Aérienne.* Par Gaston Tissandier. Hachette et Cie; octavo, 334 pp.

## THE FRENCH BATTLE-SHIP "HOCHE."

THE accompanying engraving, from the London *Engineering*, shows the French battle-ship *Hoche*, lately put into commission. At a first glance the picture shows that the ship is another instance of the propensity of the French naval constructors to pile up barbettes, turrets, casemates and other structures on their ships. Whatever may be said of their strength, this certainly does not add to their appearance.

The *Hoche* is one of the most, if not the most powerful of the battle-ships of the French Navy. Commenced in the French Government Arsenal at Orient in 1880, it was launched in 1886, and fully commissioned in the early part of this year, having been 10½ years in construction. The original design was similar to those of the other new French iron-clads *Marceau*, *Magenta* and *Neptune*, but great alterations have been made in the designs for her upper works during the construction. The hull from the keel to the water-line is constructed of iron, but all that part above water is of mild steel. The *Hoche* is built on the cellular system, and has her forward water-tight compartments filled with cellulose. She has the following principal dimensions: Displacement, 10,581 French or 10,412 English tons; length, 330 ft. at water-line; beam, 66 ft. outside armor; draft, 27 ft. 3 in.; depth, 42 ft. 2 in. The engines are four in number, two driving each of the two propellers. They are of the vertical compound type, and under forced draft indicated 12,000 H.P. on her steam trials, giving a maximum speed of 15.7 knots per hour; they indicated 7,000 H.P. under natural draft. Both engines and boilers were built by contract at the engine works of Indret, and, at a speed of 10 knots per hour, should, with the 600 tons of coal carried, enable the ship to run for a distance of 4,000 knots. The boiler pressure is 85½ lbs. per sq. in.

The *Hoche* is said to carry more artillery than any other French ship, which is probable, seeing that, including the mitrailleuses, her armament consists of nearly 50 pieces.

Two 34-cm. (13.39-in.), 52-ton guns and two 27-cm. (10.63-in.), 28-ton guns form the principal part of the armament. The two former are situated in towers, one forward and one aft, the freeboard having been kept very low for this purpose, while the two 27-cm. guns are placed in barbette towers amidships on sponsons, one on the starboard and one on the port side. In addition to this armament there are fourteen 14-cm. (5.51 in.) guns in the battery and four 14-cm. guns on the spar deck, two forward, firing ahead, and two aft, firing astern. The offensive power of the ship is completed by five tubes firing Whitehead torpedoes, and a powerful ram.

The *Hoche* is protected by an armor belt varying in thickness from 9 in. to 17¾ in., extending the whole length of the ship, and a deck armored with 3⅛-in. plates, while the forward and after turrets of the 34-cm. guns are armored with steel plates 16 in. in thickness. For defense against torpedo attacks the ship is fitted with torpedo defense netting of the Bullivant system.

There are two military masts sufficiently large in diameter to allow of free passage inside them from the upper and spar decks of the ship to either of the two military tops on each mast or to the conning-tower built round the mainmast.

The *Hoche* was commissioned at Brest in the beginning of the present year, and was then sent to Toulon to join the second division of the French Mediterranean squadron, of which she is now the flagship.

## THE HOWE TRUSS PROBLEM WITH A CARPENTER'S SQUARE.

By JOSEPH H. HOWE.

THE solutions of the Howe Truss Problem have become almost innumerable, but most of them are beyond the reach of the ordinary workman. The ideal solution for the bridge carpenter would be one which could be worked out with the square without recourse to analytical computations of any kind.

An admirable method of approximations by Professor Lænas G. Weld, which appeared in the April number of the *Transit*, 1890, furnishes a basis for a simple graphical solution of this problem.

Using the same nomenclature as he employs—viz. : $a$ = depth of panel between chords ; $b$ = length of panel from center to center of vertical rods ; $r$ = perpendicular side of angle-block ; $s$ = base of angle-block ; $c$ = width of strut ; $t$ = length of strut and $x$ = the angle the axis of strut makes with the vertical rods (see fig. 1), we have, according to his equations,

$$r = c \sin x, \text{ and } s = c \cos x, \text{ but}$$

$$\sin x = \frac{b}{\sqrt{a^2 + b^2}} \text{ approximately, and}$$

$$\cos x = \frac{a}{\sqrt{a^2 + b^2}} \text{ approximately ; substituting}$$

$$r = \frac{c\, b}{\sqrt{a^2 + b^2}} \quad (1) \text{ and}$$

$$s = \frac{c\, a}{\sqrt{a^2 + b^2}} \quad (2) \text{ approximately.}$$

In this form the carpenter might *compute* the dimensions of the angle-blocks without being familiar with trigonometric functions ; but these expressions may be evaluated graphically, using simply the carpenter's square and a straight-edged board.

Clearing (1) of fractions :

$$c\, b = r\, \sqrt{a^2 + b^2}, \text{ or writing as a proportion,}$$

$$\sqrt{a^2 + b^2} : b : : c : r \quad (3).$$

$\sqrt{a^2 + b^2}$ is the diagonal of rectangle $a\, b$. In the right-angled triangle $M\,O\,N$, fig. 2, in which $N\,O = a$ and $M\,O = b$, $M\,N = \sqrt{a^2 + b^2}$.

On the line $M\,N$, laying off $M\,Z = c$, and drawing $Z\,W$ parallel to $N\,O$, we have : $M\,N : M\,O : : M\,Z : M\,W$, a comparison of which with (3) shows that $M\,W$ is a graphical approximation to $r$.

In the same manner laying off $N\,P = c$, and drawing $P\,Q$ parallel to $O\,M$,

$$N\,Q = \frac{c\, a}{\sqrt{a^2 + b^2}}, \text{ the first approximation to } s.$$

The distances $M\,O = a$ and $O\,N = b$ may be laid off to some convenient scale, as one inch to the foot, while $c$ is laid off full size ; $r$ and $s$ will then be to full-sized scale.

Now subtracting the first result from $a$ and the second from $b$ (using scale of one inch to the foot), forming a rectangle with the remainders and drawing its diagonal, the result is the length $t$ of the strut to the scale of one inch to the foot—$M'\,N'$, fig. 2.

Then using the lessened values of $a$ and $b$ as obtained above in the diagram, and obtaining the values of $M'\,W'$ and $Q'\,N'$ exactly as $M\,W$ and $Q\,N$ were obtained, we have the second approximation for $r$ and $s$, which will be found to be sufficiently exact, although the operation may be repeated as many times as desired.

Taking Professor Weld's example, in which $a$ = 8 ft. 4½ in., $b$ = 6 ft. 6 in. and $c$ = 7½ in., a scale graduated to $\frac{1}{48}$ in. gives, for the first approximation, $r$ = 0.383 ft., $s$ = 0.494 ft., $t$ = 10.000 ft. ; and for the second approximation, $r$ = 0.375 ft., $s$ = 0.500 ft., $t$ = 10.000 ft., the latter being the exact values ; the results are reduced to *feet* for purposes of comparison.

The length of strut given by the line $M'\,N'$ is liable to a slight error, owing to the reduction of the scale ; but nothing would be gained by a second approximation.

In the drafting room, where finer instruments are at hand, the method furnishes a very accurate check upon analytical computations.

To obtain the length of strut accurately on the timber, lay off $M'\,K$ = 1 ft. (fig. 2) and draw $K\,L$ perpendicular to $M\,O$, meeting $M'\,N'$ or $M'\,N'$ produced. Using $M'\,L$ as a unit of measure as many times as the panel is feet long, the required length is obtained. A fraction of a foot may of course be added when it occurs by making

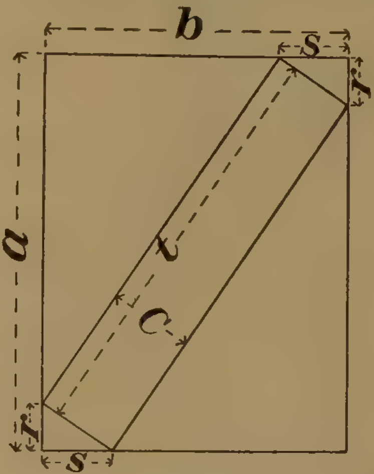



Fig. 1.

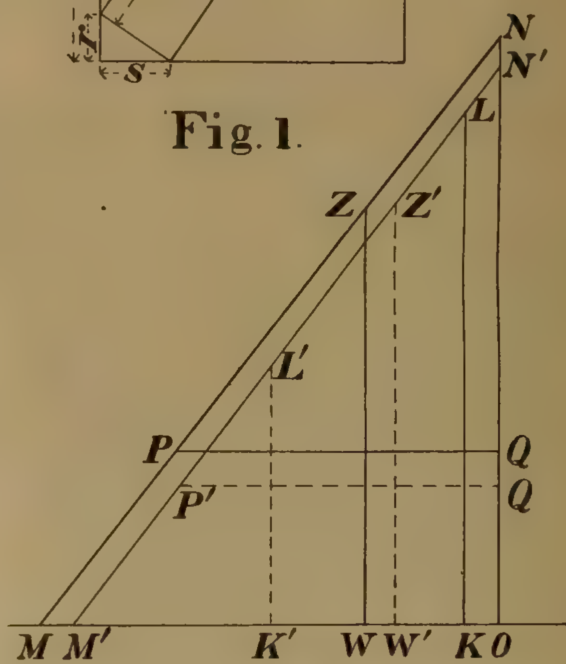



Fig. 2.

$M'\,K'$ = the fractional distance, and adding $M'\,L'$ to the length already obtained.

For the bridge carpenter we would formulate the following :

RULE.

Using a scale of 1 in. equal to 1 ft., lay off the length of panel between the centers of vertical rods upon the straight edge of a board, $M\,O$.

From one end, $O$, of the distance $M\,O$ draw a line at right angles to $M\,O$ ; lay off on this line to a scale of one inch to the foot the depth of the panel between the chords $O\,N$.

Connect $M$ and $N$ by a straight line. Beginning at the point $M$, lay off on the line $N\,M$ the distance $M\,Z$ = the *actual* width of the brace to be used, and draw $Z\,W$ parallel to $N\,O$. From the point $N$ on the line $M\,N$ lay off the distance $N\,P$ = the actual width of the brace, and consequently equal to $M\,Z$. Draw $P\,Q$ parallel to $M\,O$.

Measure the distance $M\,W$, and then lay off one-twelfth this distance (or the distance to a scale of 1 in. equal to 1 ft.) from $N$ on the line $N\,O$, making the distance $N\,N'$.

In the same manner and to the same scale lay off the distance $NQ = MM'$ upon the line $MO$.

Join $M'$ and $N'$ by a straight line.

This distance $M'N'$ is the required length of the brace to a scale of 1 in. = 1 ft.

To lay off this length full size, lay off on the edge of the board the distance $M'K = 1$ ft., and draw the line $KL$ at right angles to it until it cuts the diagonal $M'N'$ or $M'N'$ produced.

On one arm of the square take a length of one foot. $M'K$, and on the other arm the length $KL$.

Taking the diagonal connecting these two points as the unit of length, apply it to the timber as many times as there are feet in the length of the panel. Should there be odd inches in the panel length, lay off this distance (as $M'K'$) the same as the one foot $M'K$ was laid off. Draw the line $K'L'$ at right angles to it, and apply the distance $M'L'$ in addition to the distance already obtained by the application of the distance $M'L$, to get the exact length ($t$, fig. 1) in the brace required.

To obtain the actual dimensions of the angle-blocks, lay off on the diagonal $M'N'$ the actual width of the brace $M'Z'$ and $N'P'$ the same as before, and draw the lines $Z'W'$ and $PQ'$.

The length of the line $M'W'$ is the length of the vertical side ($r$, fig. 1) of the angle-block, and $N'Q'$ is the length of its horizontal side ($s$, fig. 1). These dimensions are full size.

## TESTS OF A COMPOUND LOCOMOTIVE.

We have received from Mr. A. Vail, General Master Mechanic of the Western New York & Pennsylvania Railroad, reports of a comparative test of two consolidation freight engines—one the standard pattern of the road and the other a compound engine of the Vauclain four-cylinder type—recently made on that road. This report we give herewith.

The results of the tests are given in tables 1, 2, 3, 4 and 5 appended, and in the remarks on the tests made by Mr. Vail, which are given below. A number of indicator cards taken are not given here, owing to lack of space and time.

The accompanying illustration, from a photograph, shows the compound locomotive No. 175.

The engines, as will be seen from the dimensions given below, are of the same size and identical in all respects, except as far as the different arrangement of the cylinders of the compound required. The dimensions are as follows:

| | Compound No. 175. | Standard No. 169. |
|---|---|---|
| Diameter of cylinders | H.P. 13 in. / L.P. 21 " | 19 in. |
| Stroke " " | 26 " | 26 " |
| Throw of eccentrics | 5 " | $5\frac{3}{8}$ " |
| Maximum travel of valve | 5 " | $5\frac{3}{8}$ " |
| Lead of valves | H.P. $\frac{1}{8}$ " / L.P. $\frac{3}{8}$ " | $\frac{1}{16}$ " |
| Outside lap of valves | H.P. $\frac{7}{8}$ " / L.P. $\frac{5}{8}$ " | $\frac{7}{8}$ " |
| Size of steam-ports | $21\frac{3}{4} \times 1\frac{1}{2}$ in. | $16 \times 1\frac{3}{8}$ in. |
| Size of exhaust-ports | $21\frac{3}{4} \times 7$ " | $16 \times 2\frac{3}{4}$ " |
| Bridge | 3 in. | 1 in. |
| Inside diameter of dry-pipe | $6\frac{1}{2}$ " | $6\frac{1}{4}$ " |
| Exhaust nozzles | Double, $3\frac{3}{4}$ in. | Double, $3\frac{3}{8}$ in. |
| Weight in working order | 129,600 lbs. | 126,870 lbs. |
| Weight on drivers | 116,550 " | 110,650 " |
| Weight on truck | 13,050 " | 16,220 " |
| Tubes, number and diameter | 261—2 in. | 261—2 in. |
| " length | 12 ft. $11\frac{1}{2}$ in. | 12 ft. $11\frac{1}{2}$ in. |
| Size of grate | $41\frac{1}{4} \times 101\frac{1}{2}$ in. | $41\frac{1}{4} \times 101\frac{1}{2}$ in. |
| Grate area | 29 sq. ft. | 29 sq. ft. |
| Total heating surface | 1,879 " " | 1,879 " " |
| Number of pairs of drivers | 4 | 4 |
| Diameter of drivers | $50\frac{1}{2}$ in. | $50\frac{1}{2}$ in. |
| Total wheel-base | 21 ft. 9 in. | 21 ft. 9 in. |
| Rigid wheel-base | 14 " 0 " | 14 " 0 " |
| Pressure of steam carried | 175 lbs. | 160 lbs. |
| Fuel used | Bituminous coal. | |

COMPOUND LOCOMOTIVE FOR WESTERN NEW YORK & PENNSYLVANIA RAILROAD.

BUILT BY THE BALDWIN LOCOMOTIVE WORKS, PHILADELPHIA.

### COMMENTS.

*Apparatus Used.*—Both engines had the cylinders piped for indicators in the usual way, the pipes being carefully lagged with asbestos and felting. A high grade pyrometer was inserted in the smoke-box midway between the flue sheet and the diaphragm, and placed so as to be in full view of the operator on the front end. A vacuum gauge was connected with the smoke-box by a ¾-in. pipe passing from the gauge to the cab, and by a return bend to the smoke-box; the object in this long connection being to do away with the constant jumps and vibrations of the water column.

The vacuum gauge was made of two ½-in. glass tubes 36 in. long, connected at the bottom with a rubber tube and half filled with colored water. A Thompson water meter was connected with the feed pipe, and used to

TABLE 1. FEED-WATER TEST BETWEEN BUFFALO AND MACHIAS.

| | | Standard. | Compound. |
|---|---|---|---|
| Total pounds feed water used. | Lbs. | 44788 | 36628 |
| Feed water used per hour. | Lbs. | 19473 | 16649 |
| Average I.H.P. per hour. | I.H.P. | 684.7 | 702.5 |
| Pounds feed water per I.H.P. per hour. | Lbs. | 28.44 | 23.7 |
| Pounds steam accounted for by indicator, per I.H.P. per hour, at release. | Lbs. | 23.04 | 18.01 |
| Percentage of feed water accounted for by Indicator. | % | 81. | 76. |
| Loss due to leakage, condensation and other causes, | % | 19. | 24. |
| Percentage of feed water used per I.H.P. per hour favor Compound. | % | | 16.6 |

NOTE.—Cylinder cocks and Piston packing on Compound leaking.

TABLE 3. SUMMARY OF PYROMETER AND VACUUM GAUGE READINGS ALL TRIPS MADE.

| Date. | Trip. | Engine. | Average Pyrometer. Deg. Fahr. | Average Vacuum Gauge. Inches. | Highest Pyrometer. Deg. Fahr. | Highest Vacuum. Inches. |
|---|---|---|---|---|---|---|
| Aug. 20. | South. | Standard 169. | 655° | 5.4 | 820° | 9.5 |
| Sept. 1. | " | Compound 175. | 594° | 2.6 | 812° | 7.0 |
| Aug. 21. | North. | Standard 169. | 709° | 6.6 | 820° | 10 5 |
| Sept. 2. | " | Compound 175. | 639° | 3.6 | 730° | 7.0 |
| Aug. 27. | South. | Standard 169. | 700° | 6.5 | 887° | 11.0 |
| Sept. 8. | " | Compound 175. | 646° | 1.7 | 774° | 6.5 |
| Aug. 28. | North. | Standard 169. | 695° | 7.1 | 835° | 11.0 |
| Sept. 9. | " | Compound 175. | 642° | 3 8 | 774° | 6.0 |

NOTE.—Compound trip of September 3 not included.

measure the water fed into the boiler. Only part of the test was made with the meter when an accident disabled it, the water consumption for the remaining time being taken by means of a graduated float. The feed water test of the standard engine No. 169 is based on readings from the meter.

TABLE 2. VACUUM GAUGE BETWEEN BUFFALO AND EAST AURORA.

| Speed. Miles per hour. | | Vacuum Gauge. Inches. | | Reverse Lever. Notch. | |
|---|---|---|---|---|---|
| Standard. | Compound. | Standard. | Compound. | Standard. | Compound |
| 10 | 17 | .7 | 2 | 6 | 2 |
| 24 | [illegible] | 7 | 5 | 8 | 2 |
| 23 | 23 | 7 | 3 | 9 | 6 |
| 20 | 26 | 6 | 3 | [illegible] | 6 |
| 21 | 23 | 4½ | 2½ | 9 | 6 |
| 19 | 21 | 4 | 2 | 9 | 6 |
| 16 | 19 | 5 | 2½ | 9 | [illegible] |
| 22 | 18 | [illegible] | [illegible] | 8 | [illegible] |
| 25 | 18 | [illegible] | 2¼ | [illegible] | [illegible] |
| 21 | 19 | 7 | 3 | 8 | 2 |
| 18 | 15 | 8 | 1 | [illegible] | 6 |
| 17 | 14 | 8 | ¾ | 8 | [illegible] |
| 16 | 12 | 8 | [illegible] | [illegible] | [illegible] |
| 10 | 11 | 5 | ½ | 2 | 6 |
| 22 | 10 | 8 | ½ | [illegible] | 6 |
| 18 | 9 | [illegible] | ½ | [illegible] | 6 |
| 16 | 20 | 4 | 3½ | 9 | 2 |
| 23 | 22 | 6½ | 6½ | 6 | [illegible] |
| 20 | 18 | 5½ | 4½ | [illegible] | 2 |
| 20 | 15 | 6 | 3¼ | 9 | 2 |
| 21 | 13 | 8 | 1½ | 9 | 6 |
| 23 | 14 | 8 | 1¾ | [illegible] | 6 |
| [illegible] | 20 | 10 | 5½ | 8 | 3 |
| 20 | 23 | 9½ | [illegible] | 8 | 3 |
| [illegible] | 25 | [illegible] | 4½ | 8 | 3 |

Standard Engine hauling 47 empties.
Compound Engine hauling 50 empties.

TABLE 4. VACUUM GAUGE AND PYROMETER IN CONNECTION WITH SPEED AND CARD DATA BETWEEN BUFFALO AND HOLLAND.

| Speed. Miles per hour. | | Boiler Press. Lbs. | | Throttle. | | Reverse Lever. Notch. | | I.H.P. | | Vacuum Gauge. Inches. | | Pyrometer. Deg. Fahr. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. 169. | No. 175. | No. 169. | No. 175. | No. 169. | No. 175. | No. 169. | No. 175. | No. 169. | No. 175. | No. 169. | No. 175. | No. 169. | No. 175. |
| 21.5 | 27.8 | 153 | 168 | Full | Full | 9th. | 6th. | 558 | 799 | 6 | [illegible] | 684° | 685° |
| 20.6 | 26.0 | 149 | 171 | " | " | " | " | 565 | 759 | 4½ | 2½ | 684° | 617° |
| 23.3 | 21.5 | 157 | 165 | " | " | " | " | 682 | 700 | 4 | [illegible] | 639° | 572° |
| 22.3 | 25.1 | 155 | 166 | " | " | " | " | 675 | 801 | 5 | 2½ | 639° | 594° |
| 15.2 | 16.9 | 153 | 170 | " | " | " | " | 620 | 617 | 5 | 2 | 639° | 549° |
| 16.1 | 16.1 | 146 | 168 | " | " | 8th. | " | 672 | 542 | [illegible] | 2¼ | 594° | 572° |
| 22.3 | 13.4 | 145 | 169 | " | " | [illegible] | 2d. | 748 | 706 | 7 | [illegible] | 717° | 617° |
| 17.9 | 14.3 | 149 | 173 | " | " | " | " | 601 | 790 | 8 | 3½ | 717° | 662° |
| 15.9 | 29.0 | 151 | 160 | " | " | 7th. | 6th. | 694 | 840 | [illegible] | 3½ | 819° | 639° |
| 22.3 | 16 1 | 154 | 170 | " | " | 8th. | 4th. | 823 | 832 | 8½ | 2½ | 717° | 639° |
| 26.0 | 15.2 | 158 | 168 | " | " | " | " | 649 | 657 | [illegible] | 2 | 594° | 639° |
| 24.2 | 14.3 | 143 | 173 | " | " | 9th. | " | 605 | 719 | 5½ | 2 | 752° | 662° |
| 19.7 | 12.5 | 150 | 174 | " | " | " | 2d. | 571 | 682 | 6 | 2½ | 684° | 617° |
| 32.3 | 11.6 | 153 | 172 | " | " | " | 6th. | 735 | 469 | 8 | 2½ | 662° | 594° |
| 23.3 | 13.4 | 155 | 172 | " | " | " | 2d. | 742 | 707 | 7 | 3¼ | 729° | 639° |
| 13.4 | 16.9 | 156 | 169 | " | " | 6th. | " | 836 | 985 | 4 | 3½ | 752° | 583° |
| 7.2 | 21.5 | 136 | 169 | ½ | ¾ | 1st. | 6th. | 423 | 691 | 5 | 3 | 717° | 628° |
| 15.2 | 32.6 | 140 | 170 | Full | ⅔ | 7th. | [illegible] | 676 | 741 | 6½ | [illegible] | 684° | 662° |
| 16.1 | 11.6 | 155 | 170 | " | Full | " | 2d. | 783 | 626 | 4½ | 2¼ | 717° | 594° |
| 27.8 | 15.2 | 142 | 172 | " | " | 10th. | 6th. | 474 | 563 | 4½ | 2¼ | 639° | 594° |

*Method of Getting Coal Consumption.*—The coal put on the tank was weighed on track scales at Buffalo, and on the return the coal remaining was weighed on the same scales. On the arrival of the engines at Olean the fires of both engines were cleaned and the front ends dumped. Then the fires were banked with coal taken from another engine, so that the coal noted as consumed is the amount burned while hauling the train only. No allowance was made for coal and water used while on sidings.

*Method of Getting Data.*—The weight of the trains was furnished by the Freight Department, and is the actual train weight. All delays were noted, and the time the throttle valve was closed was taken. Every two minutes of the run readings were made from the steam gauge, pyrometer and vacuum gauge. Cards were taken on an average of every two minutes. The speed was determined by a Boyer speed recorder, the chart of which was used for the vacuum gauge statements. The number of times the injector was applied was noted, and a deduction made for the water wasted from the overflow.

TABLE 5. COMPARISON OF FUEL AND WATER CONSUMPTION OF STANDARD AND COMPOUND ENGINES 169 AND 175.

First round trip Standard Engine. First round trip Compound Engine.

| Engine. | Date. | Number of Cars Handled. | Weight of Train in Pounds | Average Weight of Train. | Time on Road. | Actual Running Time. | Time Throttle was Open. | Pounds Coal Used. | Pounds Water Used. | Pounds Train Haul per lb. Coal. | Pounds Water Evap. per lb. Coal. | Average Steam Pressure. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard. | Aug. 20. | 38 emp. South. | 738960 | 1697730 | 10hrs. 35m. | 8hrs. 16m. | 7hrs. 1m. | 12800 | 86150 | 132.6 | 6.73 | 145.7 |
| | " 21. | 40L 1E. North. | 2656500 | | | | | | | | | |
| Compound. | Sept. 1. | 47 emp. South. | 1001250 | 1827615 | 10 " 23 " | 8 " 2 " | 6 " 32 " | 9580 | 73870 | 190.8 | 7.71 | 161.6 |
| | " 2. | 42L 2E. North. | 2653980 | | | | | | | | | |

Percentage of train hauled per lb. coal favor of Compound 30.5%
" " water evap. " " " " " " 12.7%

Second round trip Standard Engine. Second round trip Compound Engine.

| Engine. | Date. | Number of Cars Handled. | Weight of Train in Pounds | Average Weight of Train. | Time on Road. | Actual Running Time. | Time Throttle was Open. | Pounds Coal Used. | Pounds Water Used. | Pounds Train Haul per lb. Coal. | Pounds Water Evap. per lb. Coal. | Average Steam Pressure. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard. | Aug. 27. | 47 emp. South. | 1042450 | 1832941 | 11hrs. 16m. | [illegible]hrs. 22m. | 7hrs. 28m. | 16000 | 95640 | 114.[illegible] | 5.98 | 149.7 |
| | " 28. | 44L 2E. North. | 2623433 | | | | | | | | | |
| Compound. | Sept. 3. | 50 emp. South. | 1093200 | 1965559 | 12 " 59 " | [illegible] " 47 " | No record. | 10730 | 78520 | 183.2 | 7.32 | 166.7 |
| | " " | 46L 2E. North. | 2837918 | | | | | | | | | |

Percentage of train hauled per lb. coal favor of Compound 37.5%
" " water evap. " " " " " " 18.3%

Third round trip Standard Engine. Third round trip Compound Engine.

| Engine. | Date. | Number of Cars Handled. | Weight of Train in Pounds | Average Weight of Train. | Time on Road. | Actual Running Time. | Time Throttle was Open. | Pounds Coal Used. | Pounds Water Used. | Pounds Train Haul per lb. Coal. | Pounds Water Evap. per lb. Coal. | Average Steam Pressure. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard. | Aug. 27. | 47 emp. South. | 1042450 | 1832941 | 11hrs. 16m. | 8hrs. 22m. | 7hrs. 28m. | 16000 | 95640 | 114.5 | 5.98 | 149.7 |
| | " 28. | 44L 2E. North. | 2623433 | | | | | | | | | |
| Compound. | Sept. 8. | 47 emp. South. | 1082675 | | | | | | | | | |
| | " 9. | 45L. 2E. North. | 2870233 | 1976454 | 11 " 35 " | 7 " 36 " | 6 " 52 " | 9700 | 78460 | 203.7 | 8.09 | 169.6 |

Percentage of train hauled per lb. coal favor Compound 43.8%
" " water evap. " " " " " 26.0%

Summary of all trips made by both Engines.

| Engine. | Date. | Number of Cars Handled. | Weight of Train in Pounds | Average Weight of Train. | Time on Road. | Actual Running Time. | Time Throttle was Open. | Pounds Coal Used. | Pounds Water Used. | Pounds Train Haul per lb. Coal. | Pounds Water Evap. per lb. Coal. | Average Steam Pressure. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Standard. | Two rou'd | trips. South. | 1781410 | 3530671 | 21hrs. 51m. | 16hrs. 38m. | 14hrs. 29m. | 28800 | 181790 | 122.6 | 6.31 | 147.7 |
| | | North. | 4279933 | | | | | | | | | |
| Compound. | Three " | " South. | 3177125 | 5769628 | 34 " 57 " | 24 " 25 " | | 30010 | 230850 | 192.2 | 7.69 | 166.0 |
| | | North. | 8362131 | | | | | | | | | |

Percentage of train hauled per lb. coal favor Compound 36.2%
" " water evap. " " " " " 17.9%

No discrimination was made in regard to coal, the tenders being loaded at the regular coaling pockets, taking it as it came. The engineman and fireman were not instructed in any way as to how the engines were to be run or fired, each man exercising his own judgment both in running and firing. The trains the tests were made with were regular scheduled trains, and the same time was made as with all other regular freight trains.

Compound engine No. 175 and simple engine No. 169 are exact duplicates, except the compound cylinders on engine No. 175; they were also built at the same time, being an order of two out of an order of seven.

The tests with engine No. 169 were made under favorable circumstances, the weather being fine and the rail good. The first test with the compound was made under the same circumstances as with No. 169; the second test with No. 175 was quite different; the run from Buffalo to Olean was made in the daytime, weather fine and rail good. On reaching Olean, No. 175 was ordered to return to Buffalo with a train without having her fire cleaned or front end dumped out, and left Olean for Buffalo about 8.30 in the evening. The weather was bad and rainy, and No. 175 slipped badly, consequently more fuel was consumed than on the former trip.

We were not quite satisfied with this test, therefore thought it advisable to make one more trial trip with No. 175, which was done under favorable conditions, the weather being fine and the rail good. This made three trial trips with the compound and two with the simple engine.

Our report shows the performance of the two locomotives in the tests made, which was done with great care, and every precaution taken to make the tests between the two kinds of locomotives as complete as possible.

A careful study of the tables will show the completeness of the test, and the results will be of interest to all locomotive men.

## THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.



(*Continued from page* 423.)

### CHAPTER XIII.

### TOOTHED GEARING.

For transferring motion or power to or from revolving shafts or spindles what is called toothed gearing is used perhaps more than any other kind of mechanism. The principles of its construction have been discussed a great deal, and the student will find that much has been written about it which is hard to understand; and that there is still a good deal of difference of opinion with reference to the theory and construction of such gearing. There is not room in a series of articles like these to consider the subject fully, and therefore only some of its elementary principles will be explained here.

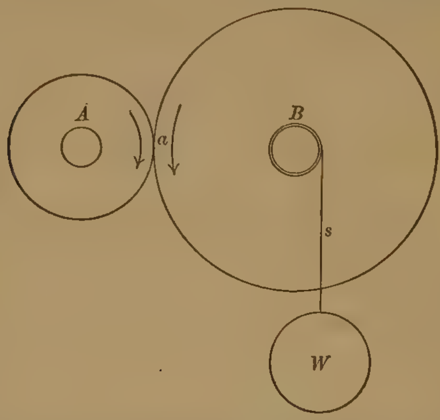
Toothed gearing may be divided into three general classes, *spur*, *bevel* and *screw* gearing. In the former, the axes of the driving and driven wheels are parallel to each other; and their action in relation to each other is similar to that of two revolving cylinders whose surfaces are in contact with each other and whose axes are parallel, as represented by fig. 333. The action of bevel wheels is similar to that of two revolving cones, whose surfaces are in contact, and whose axes may be at any angle to each other, as will be more fully explained hereafter. In screw gearing a toothed wheel is driven by a screw, and their axes are usually at right angles to each other.

#### SPUR GEARING.

If the peripheries of two wheels, *A* and *B*, fig. 333, one of half the diameter of the other, are in contact at *a*, and either (say the smaller one) is made to revolve, the other will also turn,

provided its resistance to turning does not exceed that of the friction between the surfaces in contact. If these surfaces do not slide on each other, they will both move through the same distance in the same time. This surface speed is called the *linear*

Fig. 333.

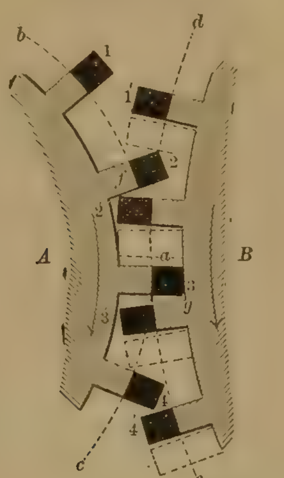



*velocity*. As the circumference of $A$, the small wheel, which is supposed to be driving $B$, the large one, is only half that of $B$, the latter will be turned only half of a revolution, while $A$ is turning all the way around—that is, while $A$ is turning 360 degrees of a

Fig. 334.

revolution $B$ is turned only 180 degrees. The amount of this turning, expressed in degrees or angular units, is called the *angular velocity*. Thus while $A$ is turning a complete revolution, or 360 degrees, $B$ is turned only half way round, or 180 degrees. The

Fig. 335.




angular velocity of $B$ is therefore only one-half of $A$. It will be seen, then, that while the linear velocity of the circumferences of the two such wheels is the same, the angular velocity of the large one is only half that of the small one. This angular velocity is always in *inverse proportion* to the diameters of the wheels. The relative velocities of wheels of different sizes will be discussed farther on.

It has been remarked that if the wheels are in contact, that if one of them is turned the other will also revolve, provided the resistance to turning is not greater than the friction between the two wheels. Suppose, now, that the wheel $B$ was required to lift a weight, $W$, by means of a string, $s$, wound around its axle. By varying the pressure of the wheel $A$ upon $B$ at the point of contact $a$, the friction between the wheels may be made sufficient for the lifting of the weight, if the latter is not too great. Two smooth wheels in contact will, however, always be liable to slip in relation to each other. As it is often absolutely essential that they should not slip at all, but that their motion in relation to each other should be "*positive*," as it is called—that is, they should always maintain definite relative positions, and also to increase their capacity for transferring power from one to the other—the peripheries of such wheels are provided with teeth which consist of projections, or *addenda* as they are called, and depressions or spaces to receive the addenda. Thus, suppose that in fig. 334 the dotted lines $b\ a\ c$ and $d\ a\ e$ represent arcs of the circumferences of the wheels $A$ and $B$, fig. 333, but drawn to a larger scale, and that the portions which are shaded in black represent the projections, or *addenda*, and that the spaces between the dotted arcs and the parts which are cross-lined represent the depressions in the wheels, it is obvious that with such wheels neither of them can turn without turning the other, unless some of the projections or teeth are broken off. It will be noticed that the spaces between the teeth are considerably wider than the teeth themselves. The latter are therefore comparatively weak, and could be easily broken. The reason why teeth of the form represented in the figure must be made narrow is in order to be able to clear each other as the wheels revolve. Thus, supposing that the wheel $A$ is driving $B$ in the direction represented by the darts, it will be seen that the tooth 2 is in contact with 2′ at $f$, and that there is then just barely enough room for the tooth 3 to clear 3′ at $g$, and for 4 to clear 4′. Consequently, when teeth are made of the shape represented, the spaces must be considerably wider than the teeth themselves. Another difficulty with this form of tooth will be seen if we suppose that $A$ is held fast in the position in which it is represented in fig. 334. $B$ could then be moved in the direction of the dart until its teeth occupied the positions shown by the dotted lines without affecting $A$. In other words, there might be what is called "lost motion" or "back-lash" between the wheels, and it would not be certain that the one wheel would drive the other at a uniform speed. If, however, the faces of the teeth, instead of being made straight, as shown in fig. 334, were curved, as in fig. 335, it will be seen that they can then be made thicker, and are consequently stronger than they would be if made of the form shown in fig. 334. It will also be plain that there is very little or no lost motion or back-lash between such teeth, and that three of the teeth on each wheel are in contact with three corresponding teeth on the other wheel at the same time, which adds to the steadiness of motion of the two wheels, and increases their durability. It is also very important that the relative velocities of the two wheels should be uniform, and that the transmission of the force from one to the other should be smooth and free from shocks or blows, and that the sliding of the teeth should cause as little loss from friction as possible.*

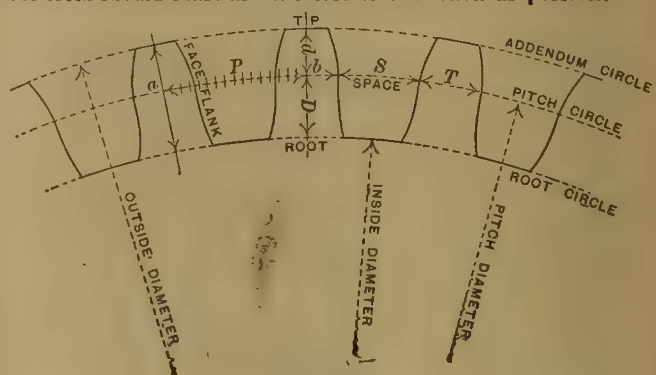



Fig. 336.

For this reason the form of the teeth should be such that the wheels will work together in precisely the same manner as if they were impelled merely by the friction of the surfaces of cylinders, or, in the case of bevel wheels, cones in contact. The attainment of these objects depends chiefly upon the form and proportions of the teeth.

* "Mechanical Drawing," by William H. Thorne.

In designing spur wheels which gear into each other, it is always imagined that there are what may be called two primitive cylinders of a given diameter which are in contact with each other. Thus in fig. 333 the two large circles represent the peripheries of the cylinders, and in figs. 334 and 335 portions of these circles are represented by dotted arcs. These circles are called the *pitch circles*. The *pitch* of the teeth is their distance apart, measured from center to center on the pitch circles, and is equal to the thickness of a tooth plus the space between adjoining teeth. Thus in fig. 336 the distance *P* from *a* to *b* indicates the pitch, which is divided into sixteen equal parts.

From the same fig. it will be seen that the outside end of a tooth is named its *tip*, its base is called the *root*; the surface outside of the pitch circle which comes in contact with the teeth of the adjoining wheel is the *face*, and that part within the pitch circle is the *flank*. The circle which defines the outside limits of the teeth or addenda is called the *addendum circle*, and its diameter is the *outside diameter*. The diameter of the pitch circle is the *pitch diameter*. The circle which defines the limits of the roots of the teeth is the *root-circle*, and its diameter is called the *inside diameter*.

In designing gear wheels, different engineers have adopted different proportions for their teeth. Unfortunately, there has been no agreement among them with reference thereto; and the learner will find that nearly every writer on the subject has adopted proportions different from his predecessors. The following are taken from Richard's "Manual of Machine Construction for Engineers," and are, perhaps, simpler than those of any other system, and probably equally as good as some which have only abstruse mathematical formulæ and Greek notation to recommend them. These proportions will be understood by referring to fig. 336, in which the same letters that are employed in the table are used to designate the same parts:

PROPORTIONS FOR THE TEETH OF GEAR WHEELS.

$P =$ Pitch which is divided into 16 parts.
$T =$ Thickness of tooth measured on pitch circle $= 7$ parts.
$S =$ Space between teeth measured on pitch circle $= 9$ parts.
$d =$ Depth from pitch circle to tip of tooth $= 5$ parts.
$D =$ Depth from pitch circle to base of tooth $= 7$ parts.
$D + d =$ Whole depth of tooth $= 12$ parts.
$R =$ Thickness of rim and arms of wheel $= 8$ parts.
$L =$ Length of tooth measured parallel to axis of wheel $= 3$ or 4 times the pitch or $4\ P$.

It will be observed that the depth of the teeth outside of the pitch circle is made less than that inside of this circle. The object of this is to prevent the tips of the teeth from touching the bottoms of the spaces between them. It will also be seen that the thickness of the teeth is less than the width of the spaces. They are made in this way when teeth are cast and used without finishing; on account of the irregularities of the teeth, there will thus be room enough for them in the spaces. The thickness of the teeth which are cut by a machine and the width of the spaces between them may be made the same or nearly so.

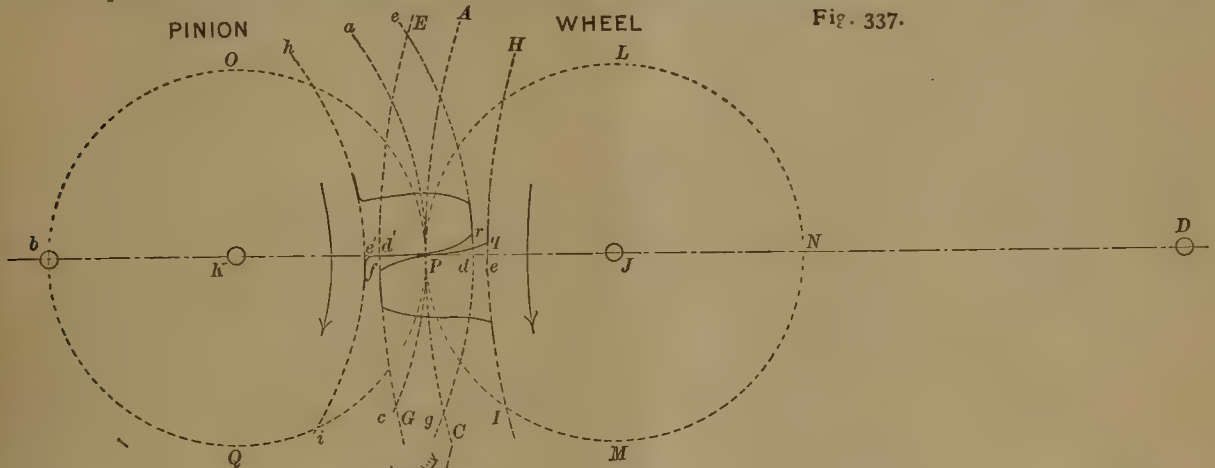



Fig. 337.

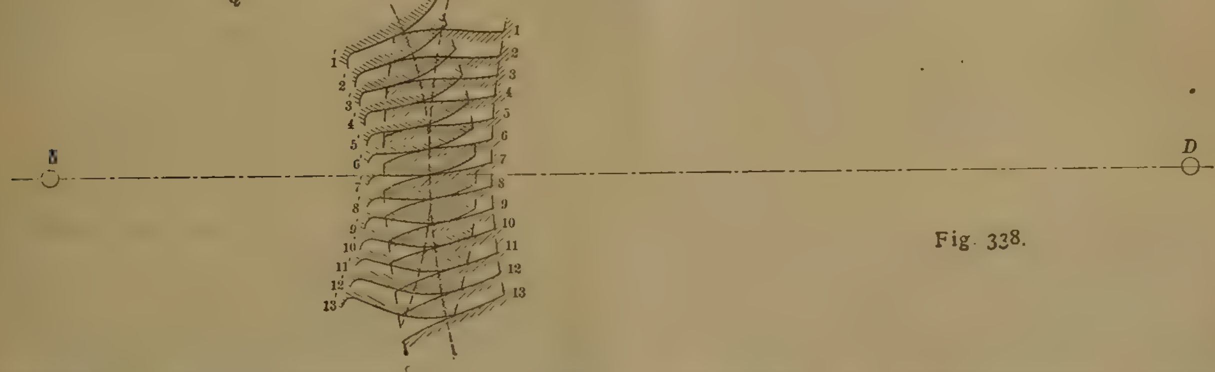



Fig. 338.

The form of the teeth of wheels should fulfill the following conditions: 1. It should be such that the linear velocity of the driven wheel at its pitch circle will be the same as that of the driving-wheel—that is, that there should be no shocks or irregularities in the relative speeds of the two wheels. 2. The friction of the teeth should be reduced to a minimum. 3. They should have the maximum strength, and to this end the strains transmitted from one wheel to the other should be distributed over as large a number of teeth as possible—that is, when they engage with each other, they should remain in contact or "have a bearing" until they are disengaged. It will be shown that these conditions will be fulfilled if their outlines are formed of cycloidal or involute curves, the reasons for which will now be explained.

CYCLOIDAL GEAR TEETH.

Let *D* and *b*, fig. 337, be the centers of a wheel and pinion, and *D P* and *b P* be radii. With *D* and *b* as centers with these radii, describe arcs *A P C* and *a P c* of pitch circles, which will be tangent to each other at *P*, and unite the centers *D* and *b* by a straight line, *D P b*. From *P* the tangent point of the pitch circles, lay off on each side distances *P d* and $P\ d' = \frac{5}{16}$ of the pitch, and *P e* and $P\ e' = \frac{7}{16}$ of the pitch. Then draw arcs of circles *E d' G*, *e d g H e I*, and *h e' i* through the points thus laid down. These arcs will define the limits of the tips and roots of the teeth.

From a center, *J*, on the line *D P b*, and with a radius equal to one-half *b P* that of the pinion *A*, describe what is called a *generating circle*, *L P M N*. Let it now be imagined that the center *D* of the wheel, *b* of the pinion and *J* of the generating circle are all fixed, and that the wheel, pinion and generating circle all turn in the direction indicated by the darts without slipping on each other at their common tangent point *P*. Let it further be supposed that a tracing point is attached to the generating circle at *P*, and that as the wheel, pinion and circle revolve, that this point describes an internal or hypocycloidal curve *p q* on the surface of the wheel and an epicloidal curve, *p r*, on the surface of the pinion.* Then as these curves are

* The method of drawing these curves was described in Chapter XI, see Problems 92 and 93.

traced simultaneously by the same point on both the wheel and pinion, the two curves will touch or be tangent to each other at every position in the path of the point.

Next, take a center, *K*, on the line *b P D*, and with a radius equal to ½ *b P* describe another generating circle, *O b Q P*,

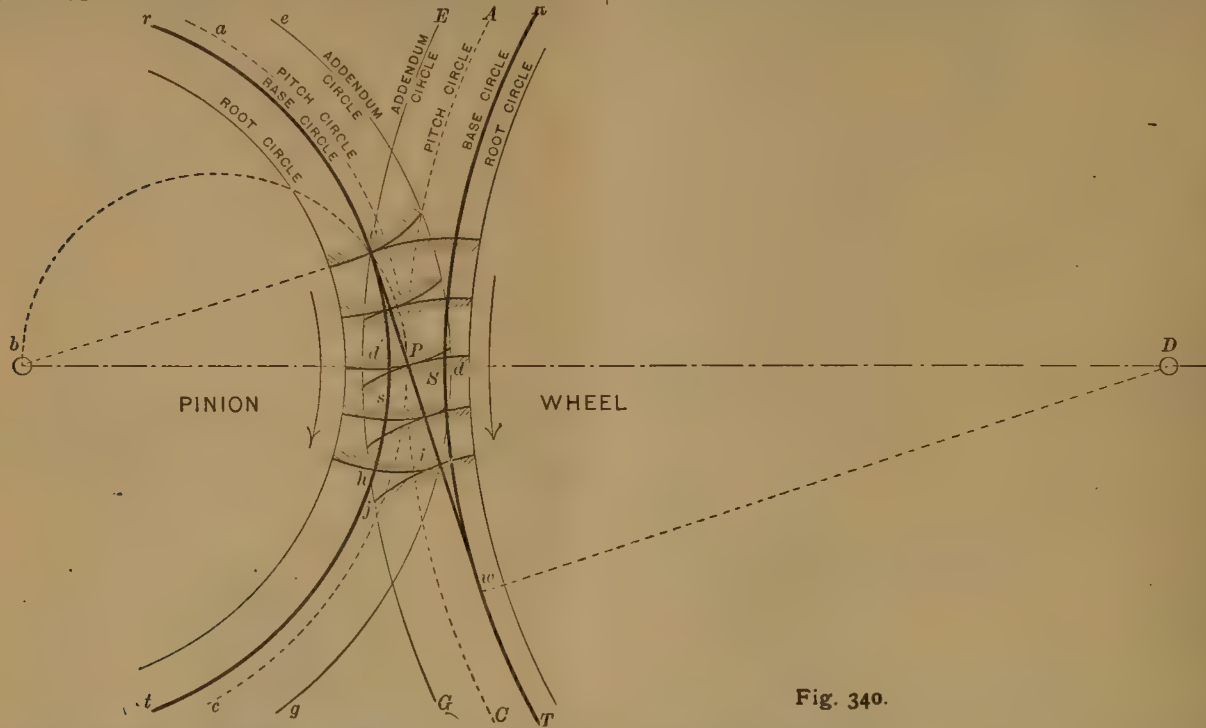



Fig. 340.

tangent to the pitch circles at *P*. Suppose, as before, that a tracing point is attached to this generating circle at *P* and that the two pitch circles and *O b Q P* are in contact at *P*, and all turn in the reverse direction to that indicated by the darts without slipping, and that the tracing point marks a curve, *P f*, on the surface of the wheel and a line, *P e'*, on the pinion. Then, as *P f* and *P e'* have also been drawn simultaneously by the same point, they must touch or be tangent to each other at every

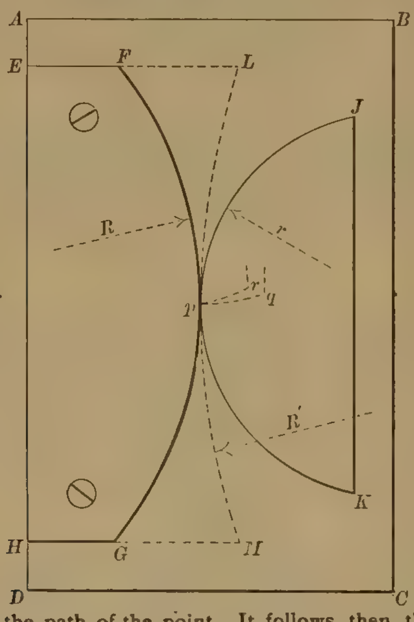


Fig. 339.

position in the path of the point. It follows, then, that if the curve *f P q* forms the outline of a tooth on the wheel, and *r P e'* that of a tooth of the pinion, that they will be tangent to each other in every position in which these outlines are in contact while the wheel and pinion revolve. This is shown in fig. 338, in which 1, 2, 3–14 and 1', 2', 3'–14' represent successive positions of the curves *f P q* and *r P e'* of fig. 337. It will be seen that they are tangent to each other in every one of these positions.

Furthermore, if the pitch circles and generating circles roll in contact with each other without sliding while the curves are drawn, their form must be produced by the angular movement of the tracing point, which is equal to that of the two pitch circles. Consequently, the motion which is transmitted from the pinion to the wheel, or *vice versâ*, will have the same velocity as that of the tracing point and pitch circles. Therefore the linear velocity of the pitch circles of a pair of gear-wheels with teeth of this form will be the same.

The method of drawing epicycloids and hypocycloids has been described in Chapter XII, and need not be repeated here. It may be done graphically by means of templates, as follows: Having the diameters of the two pitch circles and that of the generating circle, cut a template, *E F P G H*, fig. 339, whose radius *R* is equal to that of the pinion, fig. 337. Fasten this on a smooth board, *A B C D*. Then make another template, *J p K*, with a radius, *r*, equal to that of the generating circle. Place these in contact at *p*. Then roll the loose template *J p K* on the line *p F*, and place a tracing point in contact with *J p K* at *p*, so that it will trace a curve, *p r*, on the board below it. This will be the form of the face of the tooth of the pinion. Find the radius and center of an arc which approximates closely to this curve, and mark the position of the center in relation to the pitch circle *F p G*, and transfer it to the drawing. Then draw a circle through it from the center of the pinion, and the centers of the curves for all the other teeth will be on this circle. Next make another template, *E L M H*, whose outline *L p M* is concave and is drawn with a radius, *R'*, equal to that of the wheel. Then with the template *J p K* representing the generating circle, draw the curve *p q*, which will be the shape of the flank of a tooth of the wheel, which may be transferred to the drawing by the method described. In a similar way the curves for the faces of the teeth of the wheel and the flanks of those of the pinion may also be drawn by making concave and convex templates, which will conform to the lines *F p G* and *L p M* respectively.

In drawing cycloidal-shaped teeth, any sized generating circle may be used. It will be found, however, in drawing hypocycloids, that if the diameter of the generating circle is equal to the radius of the fundamental or pitch circle, as is the case with *O P Q b* in fig. 337, that the curve *P e'* becomes a straight line, and coincides with a radius of the fundamental circle. It has been found by experience, especially in small gear wheels, that if the width of the root of a tooth is less than that formed by two radii tangent to the curve of its face, that the tooth is unduly weakened. Therefore the diameter of the generating circle should not be less than the radius of the pinion. The teeth of wheels having the same pitch, which are intended to interchange with each other, should all be drawn with generating circles of the same diameter.

INVOLUTE TEETH.

The outlines of the teeth of gear wheels may also be made of involute form. Such teeth Mr. Unwin, in his "Elements of Machine Design," (new edition) says, "have two remarkable

properties. All involute wheels whose teeth have the same pitch and the same obliquity of the line of contact work well together. A pair of involute wheels may be drawn a little farther apart without the accuracy of action of the teeth being impaired, though the arc of contact is diminished. Involute wheels cannot be made with very long teeth, because then the obliquity of the line of contact must be great. Hence the centers cannot be moved much farther apart than their normal distance without too much reducing the arc of contact. But this property of involute wheels is a valuable one, as it neutralizes the injurious effect of wear of the supports of the wheels. . . . The obliquity of action is ordinarily alleged as a serious objection to involute wheels. Its importance has perhaps been overrated."

That the involute form fulfills the conditions required in the action of the teeth of gear wheels may be explained by reference to fig. 340, in which $D$ is the center of a gear wheel and $b$ that of its pinion. $A\ P\ C$ is an arc of the pitch circle of the wheel, and $a\ P\ c$ that of the pinion, the diameters being 8 in. and 4 in. respectively. Let it be supposed now that we have two wheels of which $R\ S\ T$ and $r\ s\ t$ are arcs of their circumferences, and that their diameters are somewhat smaller than those of the pitch circles, but bear the same proportion to each other. If a string, or, better, an elastic steel band, is wound around $r\ s\ t$ in the direction of the arrow, and passes between the two wheels from $v$ to $w$, and is then wound around $R\ S\ T$, also in the direction of the arrow, it is obvious that if the wheel is made to revolve in the direction indicated, that if the band does not slip it will cause the circumference of the pinion to turn with the same linear velocity as the circumference of the wheel moves. The angular velocity would also be the same as though the pitch circles were in contact and the wheels turned without slipping. From $P$, the point of contact of the pitch lines, lay off $P\ d$ and $P\ d'$, the depth of the teeth outside of the pitch circles, and draw arcs $E\ d'\ G$ and $e\ d\ g$ through the points thus laid down. If a tracing point is attached to the band at $v$, and the wheels are turned, it is plain that in moving from $v$ to $i$ the point will trace an involute curve, $h\ i$, on the surface of the pinion, and at the same time a similar curve, $j\ i$, will be traced on the surface of the wheel. As these curves are traced simultaneously by the same point, it is obvious that they must touch each other in every position of the path of the point between $v$ and $i$, and as the linear velocity of the band is the same as that of the circumferences of the wheels, if the teeth are made of the form of these curves they will impart a uniform linear velocity from the periphery of one wheel to that of the other, and all the teeth between $v$ and $i'$ will be in contact at the same time. Therefore, if the outlines of the teeth of gear wheels are made of the form of these curves, they will fulfill the requirements which are demanded of them.

The flanks of the teeth, especially those of the pinion, or that portion of the flanks within the base circle, may be made of radial form, or, in other words, formed of part of a radial line drawn through the center $b$, and tangent to the involute curve $h\ i$. In the case of involute, as with cycloidal teeth, the exact curve may be laid down for one tooth, and a radius and center of an arc of a circle may be found which will approximate most closely to the curve, and all the teeth may then be drawn with such arcs. Practically the error arising from the use of these arcs is less than would occur in attempting to make cutters to cut the teeth of absolutely correct shape, except by means of a machine which would automatically generate the curves and form the cutters to them.* In fig. 340 a number of involute curves have been drawn to show that they are tangent to each other in different positions.

(TO BE CONTINUED.)

## Gauges for the Standard Coupler.

An important circular has been issued by Secretary J. W. Cloud, of the Master Car-Builders' Association, in relation to gauges and limits for the M. C. B. standard coupler. The substance of this circular is given below:

In fulfilling the duties assigned to the Executive Committee by the Association in regard to gauges and limits for the standard contour and measurements of the Master Car-Builders' automatic coupler, when new, the Committee has carefully reconsidered the whole question since the discussion on its report to the Convention in June, and in view of this discussion and the action of the Convention upon its report, the Committee believes that it is the desire of the Association to have it act under the instructions of the Convention of 1890, and to make arrangements whereby all parties interested may be able to procure sets of gauges so that all sets will be alike, which can be used to determine whether any and all new couplers of this type are near enough to the standard contour established by the Association to insure proper coupling with one another, in so far as it can be insured by close adherence to the standard contour, and also to establish limits of variation for such of the standard rectilinear measurements of the coupler, only, as will promote the interchangeability of couplers in place upon cars.

The Committee therefore announces the gauges shown in figs. 1 and 2 for the contour line, and thickness of knuckle, respectively, with the limits of variation allowed by these gauges, and it also announces the limits for the standard rectilinear measurements, as given in the table with fig. 3.

The gauge for new couplers shown in fig. 1 is announced in lieu of the gauge proposed in the Committee's report to the Association, because it provides means for gauging the contour lines, excepting the thickness of the knuckle, at points throughout the whole essential extent of the standard form of contour, and it controls the variation in both directions from the standard, whereas the gauge proposed in the report was only a minimum gauge for a portion of the standard contour, and its use

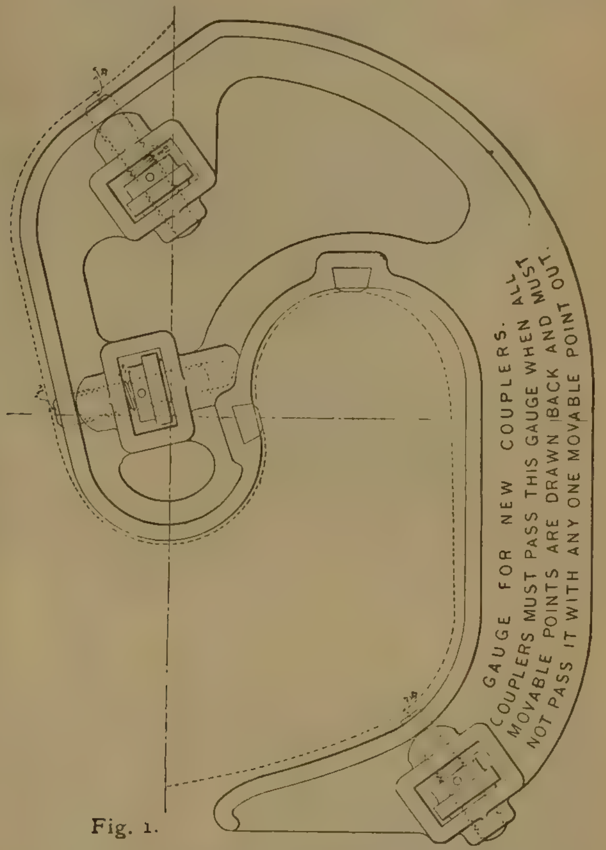



Fig. 1.

DOTTED LINE IS STANDARD CONTOUR.

would involve numerous measurements at different heights for the maximum variation, instead of gauging for both limits. The figures shown for the variation allowed with this gauge on fig. 1 are the same as those recommended in the report at the same points, and the additional point on the back of the knuckle is allowed to vary the same as was recommended at the guard arm.

The gauge for new knuckles, shown in fig. 2, is announced as a proper gauge for knuckles, allowing $\frac{1}{16}$ in. variation each way from the standard dimension of 3 in. instead of $\frac{1}{16}$ in. one way only, as recommended in the report, because it is thought desirable to allow more than $\frac{1}{16}$ in. variation, on account partly of the necessary taper in cast knuckles.

The limits shown in table given below, which belongs with fig. 3, are announced as proper limits of variation for the standard rectilinear measurements, which are the same as the limits recommended in the report, except that the standard distance $A$ of 2 in. is included herein with an allowable variation of $\frac{1}{16}$ in. each way, and the cross-section $D$ is allowed to vary $\frac{1}{16}$ in. each way from the standard measurement of 5 in., instead of only $\frac{1}{16}$ in. one way, as recommended in the report. The Executive Committee considers it inexpedient to announce limits of variation for dimensions which are not standard, but which were

* Thorne's "Mechanical Drawing."

mentioned in the report, because the Convention ordered that a committee be appointed to report next June on any new standard measurements and limits which may be desirable in connection with the coupler. It is also considered undesirable to provide any specific measuring instrument for the limits of rectilinear measurement given in table with fig. 3, as these distances may be measured in numerous ways by whatever means are best available.

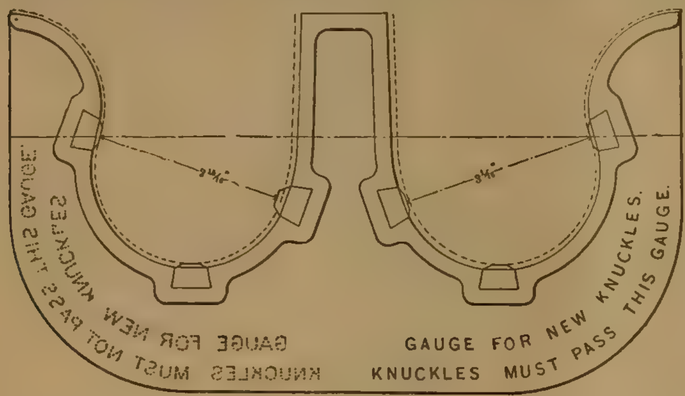



Fig. 2.

The Executive Committee has made arrangements with the Pratt & Whitney Company, of Hartford, Conn., to furnish gauges as shown in figs. 1 and 2, so that every set furnished will be like every other set, and proved by master-gauges provided and held by the Pratt & Whitney Company for that purpose, a duplicate set of which master-gauges will be filed in

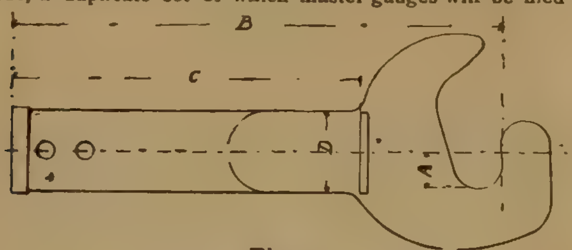



Fig. 3.

| Dimensions. | Standard. | Maximum. | Minimum. |
|---|---|---|---|
| A | 2 in. | $2\frac{1}{16}$ in. | $1\frac{15}{16}$ in. |
| B | 30 " | $30\frac{3}{8}$ " | $29\frac{15}{16}$ " |
| C | $21\frac{1}{4}$ " | $21\frac{3}{8}$ " | $21\frac{3}{16}$ " |
| D | 5 in sq. | $5\frac{1}{16}$ " | $4\frac{15}{16}$ " |

the office of the Secretary of the Association for use in settling any questions in dispute about the accuracy of gauges. The frames of the gauges will be made of the best quality of gray iron, with plain lettering, as shown on the cuts, and the gauging points will be of hardened tool steel.

The price of the gauges will be $35 per set at Hartford, providing that as many as 50 sets are ordered in advance, but if the number of sets ordered will enable them to make 100 sets in the first lot the price will be 10 per cent. less, or $31.50 per set.

Parties who wish to procure sets of these gauges should therefore place orders with the Pratt & Whitney Company at an early date, and if they prefer to do so, they can make the order conditional on the price not exceeding $35 per set, in which case the necessary fixtures, tools, etc., for making these gauges properly will not be prepared by the Pratt & Whitney Company until they have orders for 50 sets in hand.

# Manufactures.

## Baltimore Notes.

THE Baltimore & Ohio Company has recently received three passenger locomotives from the Baldwin Locomotive Works; they have 20 × 24-in. cylinders and 78-in. driving wheels. The company has recently ordered 100 Eastman heater cars from the South Baltimore Car Works and 50 Wickes refrigerator cars from the Wells & French Company, of Chicago.

A SERIES of tests of freight trains with a dynamometer car is to be made on the Baltimore & Ohio, under charge of Mr. L. S. Randolph, Engineer of Tests.

THE new shops and freight yard of the Baltimore & Ohio at Brunswick, on the main line, are to be lighted with electric lights.

THE new rail mill of the Pennsylvania Steel Company at Sparrow's Point, Baltimore, was started up for the first time recently, and is now running steadily.

THE Philadelphia Division of the Baltimore & Ohio is to be entirely relaid with 85-lb. rails. Those now in the track are 67-lb. rails. The Metropolitan Branch of the same road is to be provided with block signals throughout.

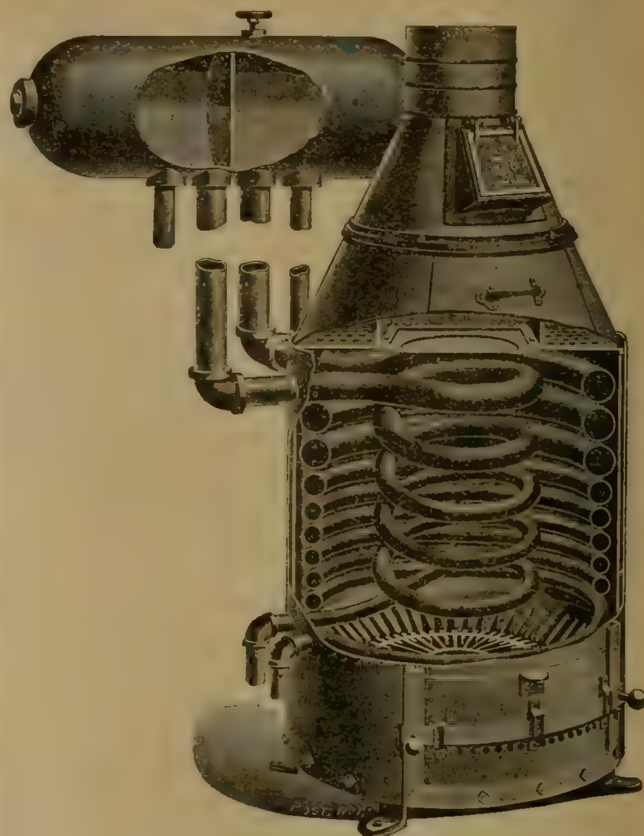
CONTRACTS for building the new North Avenue Electric Railroad have been made with Messrs. E. B. Smith & Company, the builders of the Baltimore Traction Cable Line. The rails are now being delivered, and work will be begun at once on the construction of the road, and it will be pushed to an early completion. The line will extend from North Avenue at York Road to McCullough Street, Guilford Avenue, North Lexington, Charles and Fayette Streets.

## The Two-Coil Baker Heater.

THE accompanying illustration shows the latest improvement made in the Baker heater by the use of two generator coils instead of one. The additional coil takes the place of the cast-iron lining of the fire-chamber, and thus utilizes some of the heat heretofore lost. At the same time the circulation is improved.

The water is fed to the heater in the usual manner, both circuits being supplied at the same time. Small holes in bottom and top of the partition or stay, cast crosswise in center of drum, allow the equalization of both the water and the pressure. The fire grate is the same as in the Baker perfected heater, but the grate surface is extended by openings in the rim of the ash-pit, as shown.

With these two coils it is claimed that the coal will kindle as readily, burn as freely, last as long, and leave as few clinkers



THE TWO-COIL BAKER HEATER.

as with any other heater. These are important points, and their absence has caused the failure of previous attempts to use two coils in one fire.

It is also claimed that this new circulation system has even more than double the heating power of the single circuit, for the

reason that each of the two short circuits returns to the fire (their source of heat) twice as often as the one long circuit, and one of the circuits has no cross-over pocket to contend with.

The outside, the larger of the two coils, is 46 ft. 3 in. in length, gradually increasing from $1\frac{1}{4}$ in. (the usual sized pipe of Baker heater coils) at the bottom, to 2 in. at the top end, at which point it turns upward to the circulating drum. The inner coil is 16 ft. long, and of the same proportions. The two coils are equivalent to 75 ft. of $1\frac{1}{4}$-in. pipe.

The outer steel casing and other fittings are the same as are used in the latest improved forms of this heater.

## Plate Scarfing or Planing Machine.

THE accompanying illustration shows a duplex planing machine built for the special purpose of scarfing plates used in the construction of iron and steel ships. The machine in question was built originally for the Newport News Shipbuilding Company, which needed a machine for scarfing the ends of plates used about the stern-posts and bows of ships, the idea being to accomplish this work by combining two of the machines and connecting them by a platen so arranged as to be adjustable to any desired taper.

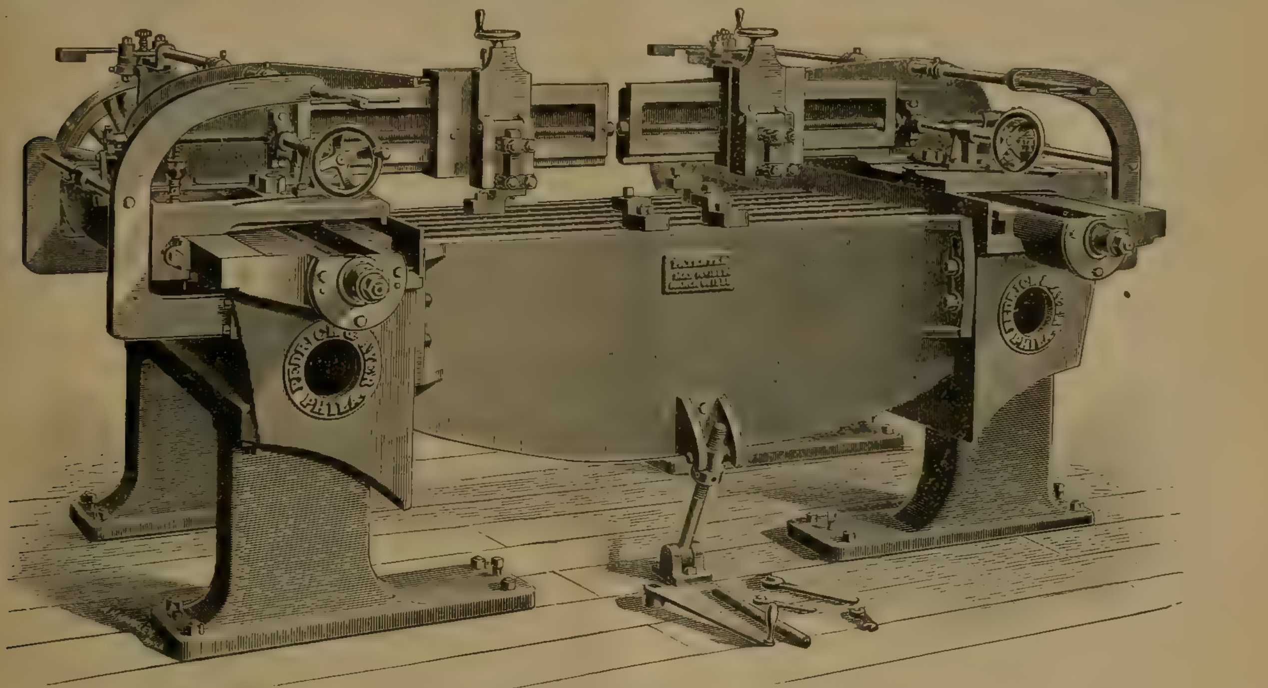


PLATE SCARFING OR PLANING MACHINE.

The machine is really a modification of the Richards patent side-planing machine arranged with right and left-hand tool supports or arms moving over the work, which may be fastened in the usual way to the slotted center-plate or table, connecting the right or left-hand beds. Each traveling head is driven independently by a separate countershaft, and wide plates or frames may be planed or spotted off, using one or both heads on hand or short stroke at will. The work, whatever its size, shape, or weight, remains at rest.

In the machine shown in the illustration the table is made to swivel or to set at certain angles by means of the screw or hand-wheel in front, and is so adjusted for the purpose of scarfing ship plates, but it may be adapted for other work of this class, changes in detail being made as desired. In the machine shown the stroke is $25 \times 60$ in., and has quick return. Furnished complete, with two countershafts, it weighs 15,800 lbs. The feet are planed on the bottom and bolted to two heavy cast-iron I-beams set on foundations. The operator stands in front between the posts where both plate shafters and all the hand wheels are easily reached.

This machine has proved exceedingly efficient in use. It is built by the well-known firm of Pedrick & Ayer, in Philadelphia.

## General Notes.

THE firm of James Reese & Son in Pittsburgh is building a steel steamboat for the Magdalena River in South America. The boat is 120 ft. long, 24 ft. beam, 3 ft. depth of hold, and will draw only 10 in. of water.

THE Servé ribbed boiler tubes, to which reference has heretofore been made, are to be tried in locomotive service, the Southern Pacific, the Mexican Central, and the Grand Trunk having ordered experimental sets of these tubes.

THE Baker Heater Company, of New York, has just shipped six of the latest improved Baker car heaters, fitted in cars built by the Gilbert Car Manufacturing Company, for the Southeastern Railway of England. There is no doubt that the Baker heater will be found a great improvement over the heating systems now in use in that country.

THE Chicago, Burlington & Quincy Railroad Company has just let a contract for 30 new passenger cars, which are to have all the latest improvements. They will be 53 ft. long over all, and will have four-wheel trucks; the wheels will be of cast iron made in contracting chills. The inside finish is to be in mahogany, and the cars will be first class and elegant in every respect. They will have the Scarritt-Forney high-back seat, with the Forney alcove under the windows. The contract has been taken by the St. Charles Car Company, St. Charles, Mo., and the cars are to be delivered during the coming eight months.

THE Centralia & Chester Railroad Company has ordered from the St. Charles Car Campany a complete train, consisting of one baggage, mail and express, one smoking, and one first-class passenger car. The latter will be a very handsome car, having inside mahogany finish, ladies' toilet and wash room, gentlemen's toilet room, and other complete fittings, including Baker improved heater. It will have the Scarritt-Forney high-back seats. This company is building a short road, but is making it a very solid and substantial line, as is shown by the character of the train mentioned. The road-bed will be good, and the locomotives are now under construction at the Baldwin Works.

THE Bucyrus Steam Shovel & Dredge Company recently furnished a quantity of dredging machinery for the works in the harbor of Montreal. These included a set of hoisting engines, which are intended to exert a direct pull of 120,000 lbs. upon a steel wire rope $2\frac{1}{2}$ in. in diameter. There are two cylinders $16 \times 18$ in. with link motion and Allen-Richardson balanced valves. The main drum is loose upon the shaft, and is driven by a friction clutch at each end. The main shaft is of steel $12\frac{1}{2}$ in. in diameter. The engine is one of the largest hoisting engines ever built.

THE new plant in the power station of the Federal Street & Pleasant Valley Electric Street Railroad Company, Allegheny, Pa., is intended to gradually replace the old complex system of centralized power with all its attendant evils of countershaft-

ing, clutches and belting. The engine is an 18 and 30 × 16 Westinghouse compound, whose governor was recently the subject of interesting experiment on rapidity of adjustment with instantaneous changes of load. As originally intended, the combination consisted of a single 225 Watt-Edison dynamo belted direct from the engine; but the imposition of a second dynamo on the engine, with increased steam pressure on account of the continued trouble with the other system, indicates the success of the change.

THE Risdon Iron Works, San Francisco, Cal., has recently completed two 500-H.P. triple expansion engines for the San Francisco & San Mateo Electric Railroad. The two engines are exactly alike. Each has cylinders 15, 24 and 38 in. in diameter, with 48-in. stroke. The high-pressure and intermediate cylinders have Corliss valve gear, and the low-pressure a slide valve and Myers cut-off. There is a jet condenser 30 × 50 in., and an independent air pump, which is driven by a compound engine with cylinders 5 in. and 10 in. in diameter, and 16-in. stroke.

THE Schenectady Locomotive Works have an order for four 10-wheel compound passenger engines for the Southern Pacific Company. These engines will have cylinders 20 and 29 in. in diameter and 24 in. stroke, and will be used in heavy passenger service between San Francisco and Sacramento.

THE Carbon Iron Company in Pittsburgh has an order for some 3,000 tons of deck and hull plates for new ships now being built at the Cramp yards in Philadelphia, Pa.

THE contracts lately received by the Pittsburgh Bridge Company include one for a bridge 400 ft. long, in seven spans, for the Great Northern Railroad Company at St. Paul, Minn.; a highway bridge of 250 ft. span at Evansville, Ind., and a highway bridge of 138 ft. span over the Antietam Creek, at Antietam, Md.

THE Lake Shore & Michigan Southern Company has asked for bids for 50 first-class passenger cars, 10 combined baggage and passenger cars, 1,000 box cars, 500 coal cars and 300 flat cars. This is one of the heaviest orders of the season, and is an indication of plenty of work for the car-builders.

THE Johnson Railroad Signal Company has the contract for the new signal system on the New York Central & Hudson River Railroad from the Grand Central Station, in New York, to Mott Haven. This will require some intricate and difficult work. The Central Company has also given orders for the extension of the block system on the Hudson River Division from Croton north. There will be 17 new towers put up, covering nearly 30 miles of road.

## Tests of Steel Wheels.

SOME tests of the wheels made by the American Steel Wheel Company have shown remarkable results. In some made at the works in South Boston a 33-in. wheel was placed on two solid iron bocks, rim resting on each block. A weight of 525 lbs., falling 17 ft., struck the hub 25 times without any effect except battering the metal. It was then dropped 10 times on the rim, without a fracture. Then a weight of 1 400 lbs. was tried, falling 17 ft., it struck the wheel 11 times but failed to break it.

At another exhibit, in order to test the expansion and contraction of the metal, a wheel was buried in sand and a charcoal fire built around the tread until it was brought to a red heat; then it was taken out and exposed to the atmosphere, which had no effect on it whatever.

The metal used in this wheel is sound, tough and homogeneous throughout, and makes a very superior Miller draw-hook and M. C. B.'s coupler.

## PERSONALS.

SYLVESTER T. SMITH has resigned his position as General Manager of the Denver & Rio Grande Railroad.

D. L. FUSNER has been appointed Master Mechanic of the Baltimore & Lehigh Railroad, *vice* W. J. KANE, resigned.

GEORGE M. ADAMS has been appointed Railroad Commissioner of Kentucky in place of J. T. HAGER, who has resigned.

ALBERT GRIGGS has resigned his position as Superintendent of Motive Power of the New York & New England Railroad.

CHIEF ENGINEER C. H. BAKER, U. S. N., has been transferred from the New York Navy Yard to duty at the Norfolk Yard.

JAMES RITCHIE has been appointed Principal Assistant Engineer of the Cleveland, Cincinnati, Chicago & St. Louis Railroad.

THEODORE COOPER, ALPHONSE FTELEY and F. P. STEARNS have been appointed Consulting Engineers of the Boston Rapid Transit Commission.

J. M. GRAHAM has been appointed Superintendent of the Ohio and Midland divisions of the Baltimore & Ohio Railroad, in place of R. BAXTER, resigned.

F. C. LEWIS, formerly with the Youngstown Bridge Company, has been appointed Chief Engineer of the Columbus Bridge Company at Columbus, O.

R. D. WADE, Superintendent of Motive Power of the Richmond & Danville Railroad and its controlled lines, has removed his office from Washington to Atlanta, Ga.

W. M. HUGHES has resigned his position as Engineer of Construction for the Columbian Exhibition, and has accepted a position with the Illinois Steel Company, in Chicago.

O. H. P. STOOP has been appointed Instructor of Civil Engineering at the Nebraska State University. His successor as City Engineer of Beatrice, Neb., is FRANK S. DAVIES.

C. F. KERCHNER, formerly Superintendent of the Baltimore & Lehigh Railroad, has been appointed Superintendent of the Monongahela Coal and Coke Company, with headquarters at Fairmont, W. Va.

GEORGE C. SMITH, formerly Chief Engineer of the Chicago, Burlington & Quincy, who for some time past has been in South America, has returned from that country, and has established an office in Chicago.

E. S. MARSHALL has resigned his position as General Master Mechanic of the St. Louis Southwestern Railroad system. His successor is R. M. GALBRAITH, formerly Master Mechanic of the road at Tyler, Tex.

E. M. HUMSTONE has been appointed General Master Mechanic of the New York & New England Railroad, with office at Norwood, Mass. He has been for some time Master Mechanic of the road at Hartford.

CHIEF ENGINEER W. W. DUNGAN, U. S. N., has been ordered to duty as President of the Naval Experiment Board at the New York Navy Yard CHIEF ENGINEER J. L. D. BORTHWICK has also been ordered to duty as a member of the Board.

R. J. GROSS has been appointed agent to represent the Locomotive Department of the Columbian Exhibition in Europe to induce foreign locomotive builders to exhibit. He has been for some time connected with the Brooks Locomotive Works at Dunkirk.

ROBERT QUAYLE is now Master Mechanic of the Milwaukee, Lake Shore & Western Railroad, succeeding Mr. John Hickey, whose appointment to the Northern Pacific has been already announced. Mr. Quayle was formerly on the Chicago & Northwestern Road.

CHIEF ENGINEER LEWIS W. ROBINSON, U. S. N., will have charge of the Machinery Department at the Columbian Exhibition. Mr. Robinson is now a member of the Naval Examining Board in Philadelphia, and had charge of the machinery during the Centennial in that city.

LIEUTENANT H. H. BARROLL, U. S. N., has been detached from duty at the Branch Hydrographic Office at Norfolk, Va., and ordered to the *Petrel*. Lieutenant Barroll is well known to readers of the JOURNAL as a frequent and very acceptable contributor to its columns.

J. S. B. THOMPSON has been appointed Assistant General Manager of the Richmond & Danville Railroad, with headquarters in Atlanta, Ga., and will have charge of the distribution of Equipment. T. O. TROY succeeds Mr. Thompson as Superintendent of the Virginia Midland Division.

W. W. THOMPSON has been appointed Master Mechanic of the New York Central & Hudson River Railroad, with headquarters in New York, where he has charge of all running locomotives. Mr. Thompson has been for several years past Road Foreman of Engines on the Manhattan Elevated Railroad.

THE candidates for State Engineer of New York, as nominated by the party conventions, are MARTIN SCHENCK (Democrat), of Greenbush, an engineer of considerable experience and for some time past connected with the State Engineer's office, and VERPLANCK COLVIN (Republican), of Albany, who

was connected with the State surveys of the Adirondack forest region.

JUDGE THOMAS M. COOLEY has tendered his resignation as Chairman and as a member of the Interstate Commerce Commission on account of failing health. Previous to his appointment on the Commission Judge Cooley had a high reputation from his intimate acquaintance with railroad and corporation law, and his services upon the bench, and he has fully maintained that reputation in the difficult position at the head of the Interstate Commission. His retirement will be a loss to the public service.

PROFESSOR N. S. CHAPLIN has been chosen Chancellor of the Washington University in St. Louis. He is a graduate of West Point, and in 1877 was appointed Professor of Civil Engineering in the Imperial University of Japan, which position he retained for five years, at the same time doing considerable service as Consulting Engineer to the Ministry of Public Works in that country. In 1882 he was appointed Engineer of Construction of the New York & New England Railroad, and had charge of the building of the second track between Boston and Hartford. After a short term as Professor in Maine College, he was in 1885 appointed Professor of Engineering in Harvard University, which position he has since held.

## OBITUARY.

WILLIAM C. STROUD died at his residence at Rosemont, Pa., September 21. He was a member of the firm of Burnham, Williams & Company, owners of the Baldwin Locomotive Works, and for a number of years had had charge of their financial affairs, acting as Treasurer of the concern. Mr. Stroud was highly esteemed by his associates, and his death will be regretted by many friends.

## PROCEEDINGS OF SOCIETIES.

**New England Roadmasters' Association.**—The Ninth Annual Convention began in Boston, August 19. The following officers were elected for the ensuing year: President, F. C. Clarke; Vice-President, C. P. Lindell; Secretary and Treasurer, G. L. R. French; Chaplain, E. W. Horner; Executive Committee, W. E. Clarke, A. C. Stickney, E. K. Post and F. Holbrook.

Interesting reports were presented by several committees. The report on Track Joints was probably the most important, and upon the whole recommended the angle-bar as the one in general use, the cheapest and most easily handled. At the same time the Committee admitted its imperfections, especially under heavy traffic, and recommended good ballast, care in fitting, and attention to the bolts as indispensable for the proper maintenance of a joint. This report was discussed at considerable length, the general feeling being in favor of a suspended joint, while the suggestion as to maintenance was generally approved. Some members complained of the inferior quality of bolts furnished and others of the lack of sufficient labor to pay proper attention to the joints.

The Committee on Fences, Cattle Guards and Crossings recommended the use of high board fences at stations and in towns and large villages. They recommended a surface cattle guard as better than a pit, and thought the best one was made of ½-in. iron strips placed on edge and held in place by a frame.

The Committee on Wear of Locomotive Tires believed that the limit of wear should be ¼ in from the standard. The Committee on Best Method of Securing Rails to the Ties thought there was no better method than to use good spikes. Rail braces were not recommended except on sharp curves, and tie-plates were thought advantageous on curves and with soft wood ties.

The attendance at the Convention was large, and there was a considerable number of exhibits of track material and appliances.

**Roadmasters' Association of America.**—The Ninth Annual Convention, which was held in Minneapolis, Minn., September 8–10, called out a large attendance, 120 members being present. There were 42 new members added to the Association, and the Secretary reported 489 members on the rolls.

At the meeting reports were presented by the Standing Committees. The Committee on Standard Frogs recommended for use on motion track a spring-rail frog for all rails 60 lbs. and over, and for yard use a rigid frog not less than 1 in 8. The report was accompanied by papers from Messrs. I. Burnett and W. H. Ellis.

The Committee on Track Joints reported progress, and appended statements of trials made of the Fisher, the McConway & Torley, the Long and the Weber joints. They also recommended the Heath and the Continuous joints to be added to the list of those on trial.

The Committee on Track Jacks made a report with recommendations, but declined to point out any particular jack for adoption.

The Committee on Track Work made a report recommending better division of sections and of the force employed, and indicating in what direction work should be applied.

On Tie Preservation the Committee gave an account of the different processes used, without making positive recommendations, but urged the selection of the best kinds of timber and greater attention to the time of cutting, to inspection and to seasoning before use. They also mentioned proper drainage and care in handling as means of prolonging life in ties.

The Committee on Interlocking Devices recommended the use of some system at all grade crossings, tunnel and drawbridge approaches and yards, and described the different systems which have been introduced.

All these reports were discussed at considerable length, and some valuable accounts of experience were drawn out by the discussions. There was also a discussion on the revision of the constitution, and the subject was finally referred to a committee. It was decided that the next meeting should be held partly in Chattanooga and partly in Atlanta.

The following officers were elected for the ensuing year: President, John Doyle, Detroit, Lansing & Northern Railroad; First Vice-President, W. A. Stearns, Chicago & Northwestern; Second Vice-President, J. B. Moll, Chicago, Milwaukee & St. Paul; Secretary and Treasurer, J. H. K. Burgwin, Grand Rapids & Indiana; Member of Executive Committee, O. F. Jordan, Michigan Central.

**National Electric Light Association.**—The Convention held in Montreal, September 7–11, was a very successful one, and we regret that space prevents us from giving a full report. There was a large attendance of electrical engineers from the United States and Canada, and the visitors were very handsomely entertained by the local Committee. Among the very important papers and discussions were those on Legislation, on Underground Currents, on Safe Wiring, on Central Stations, on Arc Light Carbons and on Rules for Wiring, but a number of other subjects were brought before the Convention.

The officers for the ensuing year are: President, C. R. Huntley, Buffalo, N. Y.; First Vice-President, James I. Ayer, St. Louis; Second Vice-President, M. J. Francisco, Rutland, Vt.; Secretary and Treasurer, John H. Beane, New York.

**Association of State Geologists.**—One of the results of the recent meeting of geologists in Washington was a resolution to form an association of Government and State geologists for the advancement of their work. The objects of this Association were defined as follows:

1. The determination of the proper objects of public geologic work.
2. The improvement of methods.
3. The unification of methods.
4. The establishment of the proper relative spheres and functions of National and State surveys.
5. Co-operation in works of common interest and the prevention of duplication of work.
6. The elevation of the standard of public geologic work and the sustenance of an appreciation of its value.
7. The inauguration of surveys by States not having such at present to co-operate with the other State surveys and with the National survey.

A committee was appointed, with Major J. W. Powell, of the United States Geological Survey as Chairman, to draw up a constitution, which is to be submitted to a meeting to be held in December next.

**Master Car & Locomotive Painters' Association.**—The Twenty-Second Annual Convention was held in Washington, beginning September 9, with a good attendance. The programme included a number of committee reports, and also questions for discussion, and it was generally carried out. The attendance at the meeting was large, and most of the reports were fully discussed.

The list of subjects, with the committees appointed to consider them, was as follows:

1. Is there a chemically pure soap that can be safely used for the purpose of cleaning the outside varnished surface of the railroad passenger-coach while in service? Stating soap, results and method of cleaning. William O. Quest, Pittsburgh & Lake Erie, Pittsburgh, Pa.; Thomas Bryne, Chesapeake & Ohio,

Richmond, Va. ; J. H. Speer, Western Railroad of Alabama, Montgomery, Ala.

2. As a question of economy and durability, should rough-stuff be discarded on the outside surface of a railroad passenger-coach ? If so, what materials and methods of application will best answer the requirements of this class of work, durability being the main consideration ? W. T. Hogan, Atchison, Topeka & Santa Fé, Topeka, Kan. ; A. R. Given, New York, West Shore & Buffalo, Frankfort, N. Y. ; A. J. Bishop, Cleveland, Cincinnati, Chicago & St. Louis, Delaware, O.

3. According to the practical experience and ideas of railroad car and locomotive painters, can a new locomotive receive a durable finish in ten days ? Stating method and materials used. A. J. Moriarty, Baltimore & Ohio, Newark, O. ; A. S. Coleman, Intercolonial Railroad of Canada, Moncton, N. B. ; J. H. Long, Chicago, Burlington & Quincy, Aurora, Ill.

4. "The cleaning of varnished surfaces of coaches, locomotives and other outside work while in service, material used, modes of application, etc."—Essay, by J. K. Lowry, Chicago, Burlington & Northern, La Crosse, Wis.

5. As an associated body, can we exert an influence on purchasing power that would remedy, where necessary, the quality of materials furnished ?—an item of great importance when viewed from the standpoint that the best procurable is the most economical, as demonstrated through practical experience in the railroad paint-shop. James A. Gohen, Chesapeake & Ohio, Huntington, W. Va. ; Robert McKeon, New York, Lake Erie & Western, Kent, O. ; A. T. Schroeder, Chicago, Milwaukee & St. Paul, Milwaukee, Wis.

6. How should the new wood head-lining material of a passenger-coach be treated to prevent the finished surface from becoming destroyed, from decay of filler, grain raising, etc., due to the interior heat and moisture of a passenger-coach ? J. T. McCracken, Delaware Car Works, Wilmington, Del. ; Edward Webb, Laconia Car Works, Laconia, N. H. ; Alexander Campbell, Manhattan Elevated, New York.

7. "Are railroad companies benefited through the Association of Master Car and Locomotive Painters ?"—Essay by Samuel Brown, Old Colony, Boston, Mass.

8. Reports of committee of 12 appointed on geographical interchange of test panels, painted and exposed for a period of 10 months, in the extreme different climatic sections of the country.

The following queries were also submitted for general discussion :

1. Would it be advisable to form a Bureau of Information in connection with our Association ?

2. Do you use all or part shellac on the hard-wood inside finish of your passenger-cars ?

3. How do you prepare your stack blacking for locomotives while in service ?

4. What materials do you use, and how long do you take, to paint your freight-cars ?

5. As an item of shop economy, in what manner can you keep your paint stock and brushes in the most serviceable state ?

6. What is the best formula for preparing floor paint for passenger-cars ?

7. What are your views concerning the piece-work system for the railway paint-shop ?

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**American Society of Civil Engineers.**—At the first meeting of the season, held in New York, September 2, papers on Concrete Beams Reinforced by Twisted Iron for Floor Construction, by E. L. Barnes ; on Longitudinal *versus* Cross Ties for Railroad Tracks, by E. E. R. Tratman ; and on Transverse Breaking Strength of Plate Glass, by G. W. Plympton, were read and briefly discussed. Several written discussions on papers previously presented were also read.

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At the regular meeting, September 16, a paper by George Y. Wisner, on the Brazos River Improvement, was read and discussed. A written discussion by Mr. Hutton, on Mr. Crowell's paper on Flood Protection at the Ravine du Sud, Haiti, was read and replied to by Mr. Crowell.

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**New England Railroad Club.**—The first fall gathering of this Club took the form of an excursion to Crescent Park, R. I., with a clam-bake and other accompaniments. The excursion was over the Old Colony Road, and by steamer on the Narragansett Bay. A large number attended, and the excursion was much enjoyed.

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**Boston Society of Civil Engineers.**—At the regular meeting, September 16, Edward G. Chamberlain, of Auburn, Mass., was elected a member.

President Stearns read a paper on Selection of Sources of Water Supply, which was discussed by members present. Mr. J. R. Freeman described and exhibited a device for testing pressure gauges.

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**Engineers' Club of Cincinnati.**—At the regular meeting, August 20, one new member was elected.

A budget of short papers by various members, on the following subjects, was read : 1. Traveling Cranes ; 2. The Width of Roadway in City Streets ; 3. Settlement of Embankments ; 4. Remarks on Water Feeding of Stationary Boilers ; 5. Railroad Spirals ; 6. Proposed Classification of Engineers ; 7. State Inspection of Bridges.

The various papers excited considerable discussion, and the last one was referred to the Standing Committee on that subject.

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**Civil Engineers' Club of Cleveland.**—At the regular monthly meeting, July 14, the report of the Club's delegate to the General Committee of Engineering Societies, Columbian Exposition, as printed and distributed, was taken up, and after some discussion the following resolution by Mr. J. L. Culley was unanimously adopted :

"*Resolved*, that this Club heartily indorse the action of the General Committee of Engineering Societies, Columbian Exposition, so far as the work has progressed, and that we are in full sympathy with the work as set forth in the report of our representatives."

The report of the Picnic Committee was presented by the Chairman, Mr. N. P. Bowler. The thanks of the Club were tendered to Mr. A. W. Johnston, Superintendent of the New York, Chicago & St. Louis Railroad, for his courtesy in providing free transportation facilities to the Club at its Annual Picnic on July 11.

Mr. James Ritchie read a paper describing a design for a built plate-girder to span a 60-ft. store front and carry the floors above of a heavily loaded building. The depth of the girder is the height of the second story, and it has openings in the web so that ordinary windows are not interfered with. The main difficulty is the transmission of shear on account of the web being interrupted by the window openings. This is overcome by forming the bottom flange partly of a 42-in. plate securely riveted at the pilasters so that the load concentrated there is transmitted through the rivets and the 42-in. plate as if the latter were the full depth of web.

In the absence of Mr. E. H. Jones, the Secretary read a paper by that gentleman on the recent Providence meeting of the American Society of Mechanical Engineers. It contained many interesting and instructive points from the papers read at that meeting.

Mr. C. P. Leland read a carefully prepared and highly interesting report upon the recent picnic of the Club.

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**Northwest Railroad Club.**—At the first fall meeting, in St. Paul, September 15, the subjects for discussion were : 1. Painting Rolling Stock, with a paper by J. O. Pattee ; 2. Fuel Economy and its Use, by P. H. Conradson. Both papers were discussed at considerable length.

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**Western Society of Engineers.**—The first meeting of the Society for the season, on September 2, took the form of an excursion in which about 150 members joined. The day was devoted to the inspection of work upon the Columbian Exhibition buildings and grounds, a visit to the Pullman Works, the inspection of several new bridges in the neighborhood of Chicago, and the new system of intersecting tracks and signals at Sixteenth Street.

In the evening a business session was held, at which the principal topic was the selection of quarters for the Society for the ensuing year.

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**Master Mechanics' Association.**—A circular from Secretary Sinclair announces the subjects for the next convention and the committees on the same as follows :

1. *Exhaust Pipes, Nozzles and Steam Passages.* Committee : C. F. Thomas, A. W. Gibbs, L. S. Randolph, J. M. Wallis, George W. Smith, Robert Quayle and John Y. Smith.

2. *Present Status of the Car Coupler Question.* Committee : John Hickey, Godfrey W. Rhodes, Sanford Keeler, R. H. Blackall and M. N. Forney.

3. *Standard Tests for Locomotives.* To investigate the practicability of establishing a standard system of tests to demonstrate the fuel and water consumption of locomotives ; also to ascertain the value of the steam-engine indicator in locomotive tests. Committee : J. N. Lauder, J. Davis Barnett, Albert Griggs, John D. Campbell and F. W. Dean.

4. *Compound Locomotives.* To investigate the relative economy of compound and simple locomotives ; also the most valu-

able form of compound locomotive. Committee: George Gibbs, William H. Lewis, Pulaski Leeds, James Meehan, T. W. Gentry and A. T. Woods. Auxiliary Committee: S. M. Vauclain, Baldwin Locomotive Works; Reuben Wells, Rogers Locomotive Works; H. N. Sprague, Porter Locomotive Works; A. J. Pitkin, Schenectady Locomotive Works; Joseph Lythgoe, Rhode Island Locomotive Works; F. J. Leigh, Canadian Locomotive Works, and D. A. Wightman, Pittsburgh Locomotive Works.

5. *Tests of Steel and Iron.* To investigate the critical temperature of steel and iron; also any other questions relating to steel and iron that the committee may consider of value. Committee: William Smith, J. N. Barr, A. W. Quackenbush, P. H. Peck and D. L. Barnes.

6. *Uniform Locomotive Performance Sheets.* To report on the practicability of establishing a system for recording the performance of locomotives that will fairly represent the work done. Committee: George F. Wilson, J. S. McCrum, John Player, James McNaughton and John A. Hill.

7. *Standard Bolts and Nuts.* To report on the best taper for bolts, and the proper size of nuts, rough and finished. Also to report on accurate measuring gauges. Committee: William Swanston, William Garstang, T. W. Gentry, W. Lavery, A. Dolbeer and L. R. Pomeroy.

8. *Boilers for High-Pressure Locomotives.* Committee: J. M. Boon, H. D. Gordon, J. S. Graham, J. H. McConnell and W. H. Marshall.

9. *Air Brake Standards and Inspection and Care of Air Brakes.* Committee: R. C. Blackall, G. W. Stevens and David Clark.

10. *Subjects for Investigation.* Committee: J. Davis Barnett, George Gibbs and William Smith.

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**Master Car Builders' Association.**—A circular from the Secretary, John W. Cloud, gives the result of the letter ballots ordered at the last Convention, as follows:

*A.* The proposed standard for lettering freight cars was rejected, failing to receive a two-thirds vote, although it had a majority of all the votes cast.

*B.* The system of joint inspection, form of joint inspection agreement, and rules governing joint inspection were rejected, also failing to receive a two-thirds vote, although they had a majority.

*C.* The form of report of defective cars was rejected, failing by only a few votes.

*D.* The joint inspection defect card was also rejected.

*E.* In the air-brake standards, the change in diameter of pins from $1\frac{7}{64}$ in. to $1\frac{3}{32}$ in. was adopted, receiving 530 votes out of 566 votes cast.

*F.* The resolution rescinding the adoption of the Fletcher lid as a standard was adopted by a vote of 417 to 149.

*G.* The proposed standard journal-box, bearing, wedge and lid for 60,000 lb. cars was adopted by a vote of 365 to 176.

*H.* The proposed lid for the old standard journal-box was adopted by a vote of 378 to 159.

The Executive Committee has arranged the following subjects, and committees to report upon them in June, 1892:

1. *Joint Inspection.* To prepare a supplementary set of interpretations and illustrations of the Rules of Interchange. A. M. Waitt, H. C. McCarty, F. D. Adams, William Garstang, Joseph Townsend, J. T. Chamberlain and D. W. Hunter.

2 *Air Brake and Signal Instructions.* To review the instructions proposed at last convention. E. W. Grieves, R. D. Wade and J. L. Greatsinger.

3. *Cast-Iron Wheels.* To investigate what improvements are being made in the manufacture of wheels, so as to secure greater uniformity in quality, in depth of chill and in distribution of metal for proper balance. George W. West, W. H. Thomas and John Player.

4. *Freight Car Truck Frames.* To report upon the relative advantages of swinging and rigid bolsters, and upon the Fox Pressed Steel Truck as compared with the prevalent forms of freight car trucks. G. F. Wilson, W. S. Morris and W. Z. Turreff.

5. *M. C. B. Automatic Coupler Standards and Limits.* To consider the standard measurements, and whether any additional or other measurements are desirable as standard, and to report upon proper limits of variation to be allowed from standard measurements. J. S. Lentz, C. A. Schroyer and J. M. Wallis.

6. *Steam Heating and Ventilation of Passenger Equipment Cars.* To report upon the general progress and the efficiency of different systems, and to present drawings for a proposed standard location of ends of train pipe, and a proposed standard connection in detail for a union between the hose and pipe, so that one style of coupling may be readily removed and another substituted in its place. J. N. Barr, J. C. Barber, W. H. Lewis, T. A. Bissell and J. W. Marden.

7. *Steel-Tired Car Wheels.* To report upon relative merits of solid cast and wrought centers, and of plate centers bolted to hubs and tires. R. E. Marshall, J. O. Pattee and C. H. Cory.

8. *Wheel Guarantee.* To consider the communication from the Wheel Manufacturers' Association, read at last convention, and to report with recommendations. J. J. Hennessey and Thomas Sutherland.

9. *Steel Plate and Malleable Iron in Car Construction.* To recommend a standard for stake pockets, and a method in detail for attaching to cars. Also to recommend standards for center plates, in detail, showing one for iron transoms and one for wooden transoms. Drawings and models to accompany the report. William Forsyth, John Mackenzie and E. D. Bronner.

10. *Standards of the Association.* To consider the standards already adopted by the Association, and recommend what measures are expedient to secure their general adoption and use. R. H. Soule, E. Chamberlain and William McWood.

11. *Metal for Brake Shoes.* G. W. Rhodes, E. B. Wall and George Gibbs.

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## NOTES AND NEWS.

**A Gas-Fired Boiler.**—A gas-fired steam boiler has been patented by J. Jackson, of Liverpool, England. One arrangement of this invention consists in combining a gas producer with a tube-filled horizontal cylindrical vessel. The producer, which is fixed at one end, is in the form of a vertical cylinder, and has a similar outer shell, the intervening space between being filled with water. The outer shell is connected with the tube-filled vessel by suitable conduits arranged to cause the proper circulation throughout the structure. The gas produced is led down through the water by a conduit and delivered into a combustion chamber, into which air suitably heated by passing

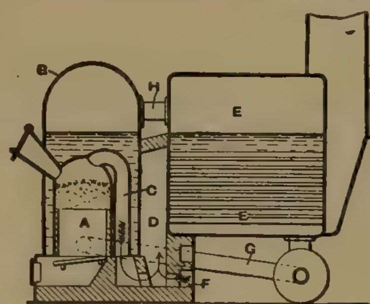


FIG. 1.

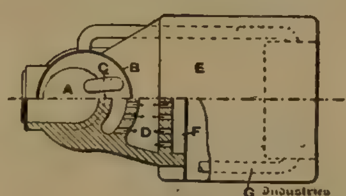


FIG. 2.

through brickwork channels is introduced. The accompanying illustrations show the invention, fig. 1 being a sectional elevation and fig. 2 a part sectional plan. The gas producer *A* has an outer shell, *B*, and conduit, *C*, leading into the combustion chamber *D*, from whence the gases pass through the tubes *E* of the cylindrical vessel. Air enters by passages *F*. *G G* are the conduits for the water, and *H* is a pipe above the water-line. Claims: The combination, in a horizontal steam generator, of a gas-producer furnace set within a shell and surrounded by water, the gas produced therein being conveyed by suitable conduits from the producer furnace and directly burned by air suitably introduced, and the gases of combustion passing over surfaces of the steam generator to be heated.—*Industries.*

**Coal in Belgium.**—The total amount of coal mined in Belgium last year was 20,565,960 tons, an increase of 5 per cent. over the preceding year. The number of persons employed in and about the mines was 116,779. The amount paid for wages averaged $1.20 per ton of coal mined, and was about 45 per

cent. of the selling price. The price of coal was higher than for several years past.

**Designs for a High Level Bridge.**—The city of Lyons, in France, is situated in a narrow valley, through the center of which flows the river Saone. On either side is a high hill or bluff, and it has been for a long time considered desirable to connect these hills by a bridge, but the width and depth of the valley is so great that until recently it has been impossible to do so. At the point where the bridge could be most conveniently built the hills are about 1,700 ft. apart and about 300 ft. in height above the river.

Two plans have been submitted for this bridge. Fig. 1 shows a bridge or viaduct proposed by M. Clavenad, the Director of Public Works of the city of Lyons. His plan provides for a viaduct to be carried on five iron piers and on a central arch composed of steel girders. The general plan is based on that of the great bridge over the Douro at Lisbon. On this plan the total length of the viaduct would be 1,850 ft., and the central arch would have a span of 700 ft. An outline of this plan is shown in fig. 1, which is taken from *Le Genie Civil*.

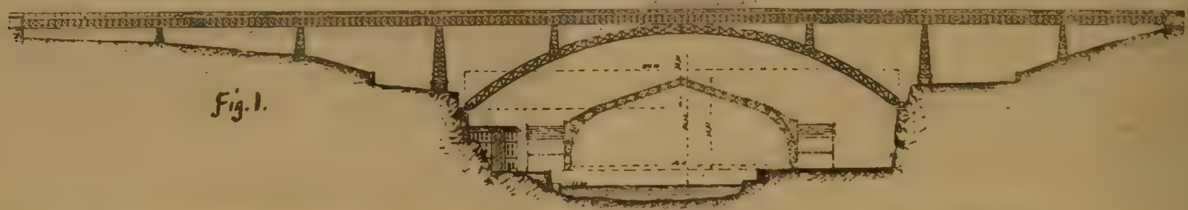

Fig. 1.

Fig. 2.

The second plan, which is shown in fig. 2, is submitted by M. Eiffel, and is for a cantilever bridge supported on stone piers, with a masonry approach at each end. On this plan the bridge will be made up of a central span of 466 ft. and two lateral spans of 279 ft. each, forming the cantilever part of the bridge; two bank spans of 207 ft. each, and the masonry approaches, one of which would be 164 ft. and the other 295 ft. long. This would make the total length of the structure 1,690 ft. This plan is shown in fig. 2.

Both of these designs are under consideration; but it is thought that the design of M. Eiffel is most likely to be accepted.

**Oiling Fixed Studs.**—A writer in *Industry*, published in San Francisco, says: "If there is anything ridiculous in common practice, it is an oil-hole drilled through the hub or boss of a pulley or wheel mounted on a fixed stud. Just how a bearing of this kind is to be oiled in that way nobody can tell, and why the oil-hole is not made in the stud itself would be a difficult problem.

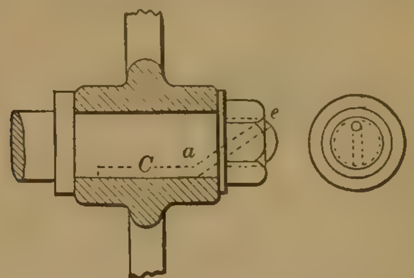


Fig. 1.

"The engraving, fig 1, shows how an oil-way should be made for a stud, as common sense will suggest. The job is still better if there is a groove cut in the bottom of the stud and some packing laid in, as shown at *C*. The best thing is a strip of felt cut from the sheet."

**Steel Chimneys.**—Steel chimneys are being erected in connection with some of Chicago's tall buildings. The Fair building has at present the tallest under construction. The chimney, when completed, will be 250 ft. high, being considerably higher than any other in the city, the highest at the present time being the one at the Gottfried Brewing Company's plant at Archer and Stewart avenues, which is 175 ft. The outside diameter is 9 ft. 5 in., while the steel varies in thickness from $\frac{5}{32}$ in. at the top to $\frac{3}{8}$ in. at the bottom. The lower 75 ft. of the chimney is lined with fire brick 8 in. deep, formed to fit the shell compactly all around. Above this it is lined with hollow tile. This lining is supported at intervals of 25 ft. by angle iron riveted to the steel shell; in other words, the chimney is lined in a manner similar to blast furnaces and foundry cupolas, and no expansion by heat can lessen its strength. The joints are all hot riveted. The steel shell is carefully protected from corrosion and from any attacks by the weather by painting inside and out. The weight of the chimney is spread to the foundations in the same general way as that of the columns of the building, the base or foundation on which it rests being constructed in the same manner. The ground is first covered with a layer of cement, then two layers of steel rails in cement and one layer of I-beams, on which the cast-iron shoe which takes the shell of the stack rests. The capacity of the chimney is twelve 60 in. boilers 20 ft. in length.

This is the first time this material has been used in the construction of the chimneys of mercantile buildings. The magnitude of the building and the necessity of economizing in space, the foundations for the columns occupying about all the ground, led the architects to adopt steel as the material for this purpose. Brick has been used almost entirely heretofore, but upon investigation it was found that the weight of a brick chimney of this size would be almost 700 tons, while of steel construction it would weigh, including the linings, a little less than 250. The outside diameter of the present chimney is 9 ft. 5 in., while were it constructed of brick it would be 16 ft. 6 in., thus making a great saving in space. Another consideration was the time consumed in construction. A brick chimney of this height, 250 ft. above the sidewalk, should not be built faster than $2\frac{1}{2}$ ft. a day on account of the settlement and the setting of the mortar, while of steel it can be erected at the rate of 20 ft. a day. Another important consideration is that it costs only about 60 per cent. of what a brick chimney would cost.—*Iron Age.*

**Compensating a Grade.**—The track of the Rainier Avenue Electric Railroad has been completed down Washington Street as far as Third, and cars are now regularly running to Eighth. The compensation weights for taking the cars up the steep incline between Fifth and Eighth streets are in place. Upon trial the contrivance has worked successfully, and cars will be running up and down in a few days.

The arrangement is a very ingenious one. The regular track is standard gauge; inside of it and 2 or 3 ft. below the street level is a second track of 2-ft. gauge. On this runs a truck loaded with lead so as to weigh beween 5 and 6 tons. This lower track is covered over, and nothing of it is seen from the street. When the truck is at the bottom of the hill a cable to which it is attached runs on pulleys to the top, and there turns over a big concealed wheel out to the side of the track.

A car coming down the hill takes the end of the cable, and the weight of the descending car, together with the electric power, draws the heavy truck underneath up the $16\frac{1}{2}$ per cent. grade to the top of the hill. When the car returns the truck is at the top of the hill. As soon as the car is attached to the end of the cable, then at the bottom, the truck is released, and its weight as it runs down draws the car up. The cable pulled out at the top of the hill as the car comes down runs in a narrow slot just inside of the track on the north side of the street. —*Seattle, Wash., Post-Intelligencer.*

# THE RAILROAD AND ENGINEERING JOURNAL.

(ESTABLISHED IN 1832.)

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NEW YORK, NOVEMBER, 1891.

IT is understood that reports have been in circulation that the RAILROAD AND ENGINEERING JOURNAL has been sold. These reports are untrue, and the JOURNAL will continue to be published under the same control and management and by the same proprietor as heretofore. The only changes to be made are in the direction of improvements which, it is hoped, will increase its interest and value to readers.

ON another page will be found the first part of an article in which the writer has endeavored to compare the English and American locomotives on the basis to which any such comparison must be brought at last—the amount of work they are doing and the cost at which that work is done. The manner in which this comparison is made is explained in the article itself. It will be followed up by a careful analysis of the performance of locomotives here and on English roads, showing the differences in the cost of locomotive service here and there. A large amount of data has been collected bearing upon these points, which it is thought will be of interest to both American and foreign engineers.

The series of papers begun by Drs. Dudley and Pease will be continued during the coming year, and will include some subjects of importance which have not yet been touched. Other papers have been arranged for, and it is believed that the JOURNAL will be able to hold the attention of its readers and to make itself acceptable to a continually increasing number.

THE success attained in transmitting power by electricity over considerable distances has attracted much attention in Europe, and in Switzerland particularly the water-powers on the small mountain streams are being eagerly taken up. These are numerous in that country, but have been neglected hitherto, because they are generally in places where it would be difficult or impossible to establish a factory. Now that it has been found that space for a water-wheel and dynamo is enough at the fall itself, the demand is so great that there is a call for some Government regulation of the subject.

AN account is given on another page of the timber tests which have been undertaken by the Forestry Division of the Department of Agriculture. The importance of this work will be appreciated by engineers generally, and it is to be hoped that they will do all in their power to help Mr. Fernow, the Chief of the Division, in his efforts to make the tests complete. A little work only from each man who is in a position to do it will make in the aggregate a very great help to the Department; and a word spoken in favor of the tests may also be of service.

THE Road Congress which is to meet in Pittsburgh on November 23 has for its object the discussion of plans for the improvement of highway roads throughout the country. It is stated that delegations from 25 States will be present, and the Congress will include many men of ability and standing. Discussion and the education of public opinion on this subject are needed, and there is much which can be done by such an assembly as that which is expected in Pittsburgh. The importance of the matter is not fully appreciated by those most directly interested, and until it is reform is not to be expected.

THE great plant which the Bethlehem Iron Company has built up for forging armor-plates and guns has now fairly begun work, and for the first time it is possible for the Government to obtain the heaviest forgings of this class at home. The establishment of such a plant in this country, where the demand for war material is intermittent, has required considerable faith in the future. That it could be done here no one doubted; the only question has been whether the demand would warrant manufacturers in putting up the costly plant required to do it.

THE needs of the Department of Transportation at the Columbian Exhibition were well presented to the American Railroad Association and the Superintendents' Society by Mr. Smith, its chief, and if the members of those bodies were thereby persuaded to take an active interest, much has been secured. The plans prepared for the buildings for the Transportation exhibit are excellent, and we regret that lack of space has prevented us from publishing them in the present number.

There is much work still to be done to bring out a proper showing. No country has done more toward improving methods of transportation than this, and the exhibition ought to be a very prominent feature of the World's Fair in 1893. Doubtless the manufacturers will be well represented, but the general and historical features ought to be shown also, and that will take time and care, if it is done properly.

THE building of underground railroads in New York, as proposed by the Rapid Transit Commission, presents so many difficult questions in engineering, that differences of opinion among experts may be expected. The reports of the consulting engineers of the Commission show that such differences exist, and that it will not be easy to reconcile all the conflicting views.

The final report of the Rapid Transit Commission, a summary of which will be found elsewhere, approves of

what has been known as the Worthen plan of four tracks on a level and generally near the surface. The Commissioners evidently hope that electricity may be used for the motors, but the use of steam may be admitted.

The report does not refer to the system which was used very successfully in London, the deep tunnel and the Greathead system of working. The plans for New York provide for tunnels much nearer the surface than that of the City & South London line, and a deeper tunnel is hardly considered practicable here. The building of the tunnel, should it be actually undertaken, will present many interesting points.

## ENGLISH AND AMERICAN LOCOMOTIVES.

I.

In *The* (London) *Engineer* of November 7, of last year, a table was published showing the traffic receipts, and also "locomotive, carriage, and wagon department expenditures" of the principal railroads in England, Scotland, and Ireland for the half of the year 1888. Since then our cotemporary has repeatedly asked for similar data concerning the performance of American locomotives. We have heretofore commented on the difficulty of furnishing such statistics for the reason that the locomotive reports published here by our railroad companies differ very widely from each other in their form, arrangement, and the information which they contain. This is not collated by any government or other authority, and therefore the only way to obtain general statistics concerning the performance of American locomotives is to apply to the superintendents of motive power of the different roads in this country for their reports. This we have done, but it has taken much time, which, with the labor of tabulating the data they contained, in order to make the various items comparable, and the subsequent explanatory correspondence, must account for the lateness of our reply to *The Engineer's* criticisms, or rather, animadversion of American locomotives. Nearly all the superintendents of motive power to whom we have applied have responded to our requests for reports and information very cheerfully and liberally, and to these our thanks are due, and are here expressed publicly.

Table I contains all the data relating to the performance of British locomotives which *The Engineer* gave last November. Table II gives similar but fuller information concerning the working of American locomotives. It should be observed that the first table, giving the performance of British locomotives, covers a period of a half year only, whereas the second, relating to American locomotives, covers a whole year.

In *The Engineer* of July 24, its editor says, rather triumphantly, that "every attempt that has been made by writers on the subject to prove the superiority of the American locomotive has been so far a dead failure." Our cotemporary does not refer to the fact that it has been clearly shown that the maximum coal consumption per square of grate per hour of American locomotives is more than twice as great as that of English locomotives, and that the quantity of water evaporated is nearly in the same proportion. On the authority of our cotemporary we have it that "about 75 lbs. (of coal) per square foot of grate per hour may be regarded as a *maximum consumption.*" We have shown consumptions of 121.6, 132.2, 148.1, and 193.7 lbs. of coal per square foot per hour, and Mr. Dean, in experiments made on the Union Pacific Railroad, burned over 200 lbs.* We have shown an evaporation of water equal to 739.12 lbs. per square foot of grate per hour with a poor quality of coal. Mr. Dean, on the Old Colony, evaporated over 1,000 lbs. with good coal. It will be shown farther on that this greater capacity for burning coal and generating steam has an important bearing on the cost of transportation.

Our esteemed disputant remarks in a recent article, that "what we have written on the subject has no doubt elicited a great deal of information which American engineers did not before possess." It seems as though some information, elicited by what has been written on this side the Atlantic, must be new, if not to British engineers, at least to our cotemporary. We submit that some advantage may be claimed for our locomotives, if they are capable of burning more than twice as much coal and evaporating nearly the same proportion of water, and can consequently pull greater loads than locomotives which do not generate a corresponding amount of steam.

But a study of what we may call our international tables will reveal some other information which perhaps British engineers "did not before possess." In these tables it will be seen that the number of locomotives owned by the different companies is given in the second column, the total mileage in the third, and the average mileage in the fourth. At the foot of this column the aggregate average mileage is given. This is obtained by dividing the total engine mileage by the whole number of engines. In Table II the total number of all locomotives capable of service, and owned by different American railroad companies, is given. Whether the table of English engines gives *all* the engines owned or only those in service, we are unable to say. It will be seen, though, that the average mileage of British engines for a half year was 12,305, equivalent to 24,610 miles per year. The average of nearly 15,000 American locomotives, as shown by our table, was 35,650 miles. When facts of great importance are announced simply by two sets of figures, they often do not convey an adequate idea of their significance. We, therefore, represent graphically the relative average mileage of locomotives here and on the other side the water, by the following diagram, in which the lengths of the dark lines represent the proportionate average service which British and American locomotives perform annually.

AVERAGE ANNUAL MILEAGE OF ENGLISH LOCOMOTIVES.

24,610 miles.

AVERAGE ANNUAL MILEAGE OF AMERICAN LOCOMOTIVES.

35,650 miles.

To show the *maximum* mileage, we have obtained from a number of different roads the greatest distance run by each of three engines, which ran farthest during the last year. The results are given in Table III.

We have seen the report of the remarkable mileage of the "Charles Dickens" on the London & North Western, which ran a million miles in less than ten years, or an annual mileage during that time of over 104,000 miles, which exceeds anything in our table. The figures which we give are, however, taken from ordinary, every-day practice of 33 different roads. Can *The Engineer* give its

* The coal used on the Union Pacific is of a very free-burning quality.

TABLE I. SHOWING THE TRAFFIC RECEIPTS, ALSO LOCOMOTIVE EXPENDITURES OF THE UNDERNOTED RAILWAYS OF ENGLAND, IRELAND AND SCOTLAND FOR THE HALF YEAR ENDING 30TH JUNE AND 31ST OF JULY, 1888.

| 1<br>NAME OF ROAD. | 2<br>Number of Locomotives. | 3<br>Total Mileage of Locomotives for Half Year. | 4<br>Average Mileage for Half Year. | 5<br>Traffic Receipts per Train, Mile.<br>Pass. | 6<br><br>Goods. | 7<br>Coal Consumed per Engine, Mile. | 8<br>Cost of Fuel per Engine, Mile. | 9<br>Cost of Repairs per Engine, Mile. | 10<br>Cost of Working per Mile Run. | 11<br>Total Cost of Locomotive Service per Engine, Mile. |
|---|---|---|---|---|---|---|---|---|---|---|
| ENGLISH. | | | | £ | £ | lbs. | cts. | cts. | cts. | cts. |
| London and North Western | 2,323 | 27,035,313 | 11,658 | 4/ 0.49 | 6/ 7.52 | 40 04 | 2.51 | 5.32 | 10 92 | 18.75 |
| Great Western | 1,600 | 19,107,351 | 11,943 | 4/ 3.86 | 5/ 3.76 | 32.51 | 2.36 | 6.02 | 9.18 | 17.56 |
| Midland | 1,807 | 21,270,252 | 11,771 | 3/ 2.37 | 5/ 2.23 | 39.51 | 2.56 | 4.74 | 10.30 | 17.60 |
| North Eastern | 1,506 | 17,102,558 | 11,356 | 3/ 2.34 | 6/ 2.00 | 36.52 | 2.54 | 8.98 | 11.22 | 22.74 |
| Lancashire and Yorkshire | 948 | 11,611,396 | 12,248 | 3/ 5.50 | 7/10.21 | 39.62 | 2.33 | 6.10 | 11.38 | 19.81 |
| Great Northern | 798 | 10,333,286 | 12,949 | 3/ 0.13 | 4/ 6.32 | 40.65 | 3.11 | 4.72 | 10.48 | 18.31 |
| Great Eastern | 733 | 9,530 014 | 13,001 | 3/ 5.09 | 5/ 0.52 | 35.21 | 3.63 | 4.32 | 10.40 | 18.35 |
| London and South Western | 548 | 8,023,716 | 14,642 | 4/ 4.52 | 5/ 7.41 | 26.90 | 3.48 | 4.08 | 12.10 | 19.66 |
| London, Brighton and South Coast | 410 | 4,839,860 | 11,805 | 4/ 2.91 | 7/ 4.28 | 29.42 | 4.90 | 4.28 | 12.54 | 21.72 |
| South Eastern | 338 | 4,618,454 | 13.664 | 4/11.84 | 6/10.42 | 32.75 | 3.84 | 3.62 | 12.14 | 19.60 |
| London, Chatham and Dover | 180 | 2,389,980 | 13,278 | 4/ 9.42 | 8/10.53 | 30.95 | 4.76 | 5.22 | 12.74 | 22.72 |
| North Staffordshire | 131 | 1,375,348 | 10,499 | 3/ 0.17 | 7/ 7.78 | 38.66 | 2.22 | 6.58 | 7.44 | 16.24 |
| Furness | 119 | 892,938 | 7,504 | 2/10.81 | 11/ 2.01 | 46.22 | 4.23 | 4.84 | 15.18 | 24.25 |
| Taff Vale (Wales) | 169 | 2,238,082 | 13,243 | 5/ 5.97 | 7/11.59 | 38.49 | 2.76 | 11.74 | 10.94 | 35.44 |
| Metropolitan | 67 | 1,090,650 | 16,278 | 6/ 0.14 | —— | 37.20 | 6 07 | 4.76 | 13.90 | 24.73 |
| Metropolitan District | 54 | 819,148 | 15,169 | 4/11.39 | —— | 30.50 | 5.13 | 3.72 | 11.66 | 20.51 |
| North London | 80 | 1,236,771 | 15,460 | 3/ 4.69 | 11/ 5.52 | 30.73 | 5.28 | 5.54 | 13.90 | 24.72 |
| Cambrian | 51 | 667,298 | 13,084 | 2/11.38 | 4/ 1.96 | 35.87 | 2.92 | 3.78 | 9.04 | 15.74 |
| Maryport and Carlisle | 26 | 257,631 | 9,909 | 2/10.00 | 6/ 2.60 | 45.00 | 4.18 | 5.82 | 11.34 | 21.34 |
| Total | 11,888 | 144,440,046 | 12,150 | 3/10.24 | 5/11.07 | 36.61 | 2.90 | 5.54 | 10.92 | 19.36 |
| IRISH. | | | | | | | | | | |
| Great Southern and Western | 176 | 1,868,913 | 10,619 | 3/ 8.34 | 5/10.93 | 27.24 | 3.72 | 6.18 | 10.06 | 19 96 |
| Midland Great Western | 104 | 1,124,608 | 10,814 | 3/ 3.25 | 6/ 7.68 | 29.03 | 3.72 | 5.04 | 8.96 | 17.72 |
| Dublin, Wicklow and Wexford | 51 | 616,892 | 12,096 | 3/10.48 | 5/ 0.13 | 27.11 | 3.60 | 3.60 | 8.56 | 15.76 |
| Belfast and Northern Counties | 52 | 597,631 | 11,493 | 2/ 5.99 | 5/ 6.13 | 27.01 | 3.49 | 3.44 | 8.80 | 15.73 |
| Great Northern | 137 | 1,791,033 | 13,073 | 3/ 3.72 | 6/ 4.84 | 26.76 | 3.61 | 3.88 | 9.08 | 16.57 |
| Total | 520 | 5,999,077 | 11,537 | 3/ 4.81 | 6. 1.25 | 27.39 | 3.65 | 4.74 | 9.26 | 17.65 |
| SCOTTISH. | | | | | | | | | | |
| Caledonian | 690 | 8,634,143 | 12,513 | 3/ 5.02 | 5/ 9.79 | 49.65 | 2.09 | 4.46 | 8.54 | 15.09 |
| North British | 610 | 9,453,125 | 15,497 | 3/ 3.09 | 4/ 9.32 | 43.04 | 2.09 | 3.06 | 8.64 | 13.79 |
| Glasgow and South Western | 291 | 3,428,202 | 11,781 | 3/ 8.39 | 5/ 4.07 | 48.37 | 2.44 | 4.52 | 8.74 | 15.70 |
| Great North of Scotland | 74 | 1,216,745 | 16,443 | 2/11.33 | 5/ 2.68 | 37.37 | 3.58 | 3.54 | 8.74 | 15.86 |
| Total | 1,665 | 22,732,215 | 13,653 | 3/ 4.41 | 5/ 3.25 | 46.04 | 2.22 | 3.82 | 8.62 | 14.66 |
| Aggregate Total | 14,073 | 173,171,338 | 12,305 | 3/ 9.30 | 5/10.08 | 37.53 | 2.84 | 5.30 | 10.58 | 18.72 |

readers a report similar to ours of the maximum mileage of English locomotives in ordinary service?

It seems hardly necessary to dwell upon the advantage which American locomotives possess over their Anglican cotemporaries, in their greater capacity for doing what they are made for—that is, for running and pulling trains. If we were arguing about horses, it would be apparent that an animal which would travel, on an average, 35 miles per day was a much more serviceable and more valuable beast than one which would travel only 24 miles, even though the one which could travel farthest eat more oats than the other. The same thing is true of locomotives. Railroad companies buy, build, and own them for the service they can perform. That is what gives them value. Our adversary, apparently, entertains—vaguely, perhaps—the idea that the "chief end" of a locomotive is to evaporate the largest quantity of water per pound of coal. A maximum evaporation of water is of some importance, but to a railroad company, crowded with traffic, and an insufficient equipment, the *service capacity* of their locomotives is paramount to everything else. Its influence on the interest account is a matter of simple calculation. Supposing a road, say in some new country, is equipped with 250 American locomotives. These, at $8,000 each, would cost $2,000,000. To do the same work, 375 English locomotives would be needed at a cost—assuming the same price—of $3,000,000. That means, of course, $1,000,000 more capital and an annual interest charge of $50,000, without any allowance for deterioration. It also means more engine-house capacity, more men to take care of engines, more yard and shop room, and a very great addition of expense in the locomotive department.

The last number of "Poor's Railroad Manual" gives the total number of locomotives owned by the railroads of the United States at 32,241. If the annual mileage of American locomotives did not exceed that of their English cotemporaries, 46,704 locomotives would be required to do the work which the 32,241 are now doing. That is, 14,463 *more* than are now owned would be required to do the work of our railroads. At $8,000 apiece, this additional equipment would cost $115,704,000.

The remark of *The Engineer* that "every attempt that has been made by writers on the subject to prove the superiority of the American locomotive has been so far a dead failure," has already been quoted. It says, "The facts are too strong." Now we submit to our esteemed

TABLE II. SHOWING THE LOCOMOTIVE EXPENDITURES OF THE UNDERNOTED RAILWAYS IN THE UNITED STATES AND CANADA FOR THE YEAR 1890.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NAME OF ROAD. | Number of Locomotives owned by Company. | Total Mileage of Locomotives for Year. | Average Annual Mileage of Locomotives. | Average Number of Cars per Train. | | Coal Consumed per Engine, Mile. | | | Cost of Fuel per Engine, Mile. | Cost of Repairs per Engine, Mile. | Cost of Oil Waste and Miscellaneous Supplies per Mile Run. | Wages of Engineer, Fireman, and Cost of Cleaning per Engine, Mile. | Total Cost of Locomotive Service per Engine, Mile. |
| | | | | Pass. | Frg't. | Pass. | Frg't. | Pass. and Fr'g't. | | | | | |
| | | | | | | | | lbs. | cts. | cts. | cts. | cts. | cts. |
| Boston and Albany* | 240 | 5,979,896 | 24,916 | | | | | 69.00 | | 4.40 | 0.56 | | |
| Boston and Maine† | 448 | 11,934,272 | 26,661 | | | | | 47.50 | 10.14 | 3.11 | 0.39 | 6.74 | 20.38 |
| Burlington, Cedar Rapids and Northern | 104 | 3,424,314 | 32,926 | 3.65 | 15.40 | | | 75.00 | 5.73 | 3.87 | 0.41 | 6.91 | 16.92 |
| Canadian Pacific | 532 | 17,474,438 | 32,847 | | | | | 62.00 | 11.07 | 3.83 | 0.39 | 6.50 | 21.79 |
| Chesapeake and Ohio | 238 | 8,797,269 | 36,963 | 4.52 | 18.90 | 63.65 | 127.39 | | 4.02 | 4.54 | 0.29 | 6.59 | 15.44 |
| Chicago and Alton | 207 | 7,044,699 | 34,032 | 5.20 | 20.32 | 72.3 | 96.1 | 80.00 | 4.31 | 3.62 | 0.60 | 8.00 | 16 53 |
| Chicago, Burlington and Quincy | 473 | 19,259,373 | 40,717 | 4.99 | 18.22 | | | 82.71 | 5.72 | 4.70 | 0.35 | 7.04 | 17.81 |
| Chicago, Milwaukee and St. Paul | 757 | 27,636,934 | 36,504 | | | | | 70.90 | 7.21 | 3.82 | 0.26 | 6.86 | 18.15 |
| Chicago, Rock Island and Pacific | 534 | 19,242,100 | 36,034 | | | | | 60.00 | 5.77 | 3.07 | 0.32 | 6.57 | 15.73 |
| Chicago, St. Paul, Minneapolis and Omaha | 230 | 7,031,562 | 30,572 | | | | | 70 00 | 10.17 | 3.94 | 0.38 | 7.14 | 21.63 |
| Chicago and North Western | 806 | 30,495,091 | 37,833 | | | | | 78.70 | 7.14 | 3.67 | 0.35 | 7.00 | 18.16 |
| Cincinnati Southern | 226 | 7,684,118 | 34,000 | 4.30 | 22.80 | 55.00 | 98.00 | 71.00 | 5.80 | 4.40 | 0.30 | 7.40 | 17.90 |
| Cleveland, Cincinnati, Chicago and St. Louis | 438 | 15,723,929 | 35,899 | 4.50 | 21.40 | 63.21 | 106.72 | 80.29 | 5.69 | 3.19 | 0.32 | 6.78 | 15.98 |
| Delaware, Lackawanna and Western | 244 | 8,147,097 | 33,389 | | | | | 78.00 | 5.99 | 3.26 | 0.46 | 5.81 | 15.52 |
| Fitchburg | 221 | 6,304,182 | 28,525 | | | | | 71.90 | 10.89 | 4.61 | 0.66 | 9.27 | 25.43 |
| Illinois Central | 535 | 18,605,304 | 34,776 | 4.49 | 15.36 | 74.9 | 108.4 | 90.60 | 4.59 | 3.34 | 0.28 | 6.46 | 14.67 |
| Kansas City, Ft. Scott and Memphis | 149 | 4,770,148 | 32,014 | | | | | 60.30 | 5.21 | 4.12 | 0.24 | 7.14 | 16.71 |
| Lake Shore and Michigan Southern | 549 | 19,509,322 | 35,536 | | | | | 62.80 | 4.36 | 4.84 | 0.16 | 6.84 | 16.20 |
| Louisville and Nashville | 462 | 17,990,574 | 38,940 | 5.11 | 13.11 | 60.5 | 93.3 | | 7.16 | 5.17 | 0.27 | 7.98 | 20.58 |
| Michigan Central | 420 | 16,200,768 | 38,573 | 5.50 | 32.00 | 72.71 | 128.00 | | 6.93 | 3.36 | 0.26 | 5.33 | 15.88 |
| Milwaukee, Lake Shore and Western | 100 3/12 | 3,903,620 | 38,939 | | | | | 75.70 | 10.64 | 2 56 | 0.31 | 6.64 | 20.15 |
| Missouri, Kansas and Texas | 212 | 8,559,852 | 40,376 | 4.80 | 16.91 | | | 83.10 | 8.32 | 4.66 | 0.42 | 7.93 | 21.33 |
| Missouri Pacific | 309½ | 10,825,213 | 35,033 | 4.56 | 18.32 | | | 87.00 | 6.99 | 4.77 | 0.45 | 7.73 | 19.94 |
| Mobile and Ohio | 98 | 3,137,928 | 32,019 | | 23.4 | | | 63.40 | 3.86 | 3.97 | 0.35 | 6.90 | 15.08 |
| New York Central and Hudson River | 800 | 27,456,016 | 34.320 | 5.00 | 33.90 | | | | | 2.61 | 0.33 | 6.25 | |
| New York Elevated | 250 | 8,541,037 | 34,164 | 4.56 | | 47.85 | | 47.85 | 8 90 | 1.70 | 0.30 | 8.62 | 19.52 |
| New York, Lake Erie and Western | 556 | 19,672,746 | 35,383 | 4.90 | 21.80 | 85.00 | 122.4 | | 6.83 | 5.32 | 0.41 | 8.18 | 20.74 |
| New York, New Haven and Hartford | 190 | 7,966,161 | 41,927 | | | | | 60.00 | 8.48 | 3.61 | 0.64 | 7.37 | 20.10 |
| New York, Pennsylvania and Ohio | 254 | 8,153,297 | 32,099 | 5.10 | 19.10 | 70.00 | 117.9 | | 5.68 | 4.17 | 0.31 | 7.60 | 17.76 |
| Ohio and Mississippi | 116 | 4,605,967 | 37,982 | | | | | 73.60 | 3.54 | 3.59 | 0.20 | 6.78 | 14.11 |
| Old Colony† | 227 | 6,558,675 | 28,893 | | | | | 55.80 | 11.18 | 3.49 | 0.58 | 7.54 | 22.79 |
| Pennsylvania (United R.Rs. of New Jersey) | 385 | 12,076,374 | 31,341 | 4.94 | 23.67 | 82.4 | 108.8 | 78.40 | 11.59 | 6 21 | 0.72 | 6.45 | 24.97 |
| Pennsylvania (Philadelphia to Pittsburg) | 991 | 31,648,320 | 31,936 | 4.95 | 24.37 | 67.5 | 136.00 | 100.60 | 5.75 | 5.28 | 0.50 | 6.22 | 17.75 |
| Pennsylvania Lines West of Pittsburg (N. Western System) | 441 | 16,188,889 | 36,710 | 5.33 | 23.87 | 58.87 | 100.36 | | 5.00 | 4.96 | 0.32 | 6.74 | 17.02 |
| Philadelphia and Erie | 186 | 5,268,503 | 28,325 | 3.84 | 32.66 | 60.00 | 153.8 | 124.30 | 7.41 | 6.29 | 0.38 | 6.16 | 20.24 |
| Philadelphia, Wilmington and Baltimore‡ | 193½ | 7,505,439 | 38,788 | 4.40 | 17.40 | | | 62.00 | 8.50 | 6.05 | 0.58 | 5.62 | 20.75 |
| St. Louis and San Francisco | 169 | 5,570,373 | 32.690 | | | | | 80.10 | 5.89 | 4.85 | 0.34 | 7.59 | 18.67 |
| Union Pacific | 909 | 34,846,343 | 38,334 | 5.16 | 16.26 | | | 94.50 | 10.26 | 6.60 | 0.45 | 9.14 | 26.45 |
| Wabash | 403 | 15,099,843 | 37,468 | 4.79 | 22.13 | | | 74.24 | 4.53 | 3.17 | 0.35 | 7.11 | 15.16 |
| Western New York and Pennsylvania | 121 | 3,959,957 | 32,727 | 3.30 | 20.40 | | | 78.70 | 5.06 | 3.76 | 0.37 | 6.55 | 15.74 |
| Wisconsin Central | 134 | 5,089,187 | 37,079 | | | | | 75.80 | 9.19 | 3.46 | 0.25 | 6.92 | 19.82 |
| Totals | 14.863 3/12 | 519,889,130 | | | | | | | | | | | |
| Averages | | | 35,650§ | | | | | 74.37¶ | | 4.25** | 0.39†† | 7.06** | 18.87‡‡ |

* This Company has a large number of old locomotives too light for its service which make little mileage.

† A considerable proportion of the engines of this Company are not employed in winter.

‡ The engines and mileage on the Baltimore and Potomac road are included here.

§ This average is obtained by dividing the total number of miles run by the total number of engines.

¶ This is the result of multiplying the number of miles run on each road by the quantity of coal burned and adding the products thus obtained and dividing by the sum of the mileages on all the roads.

** This average is obtained in the same way as that at the foot of column 9, but using the cost of repairs per mile run on each road as a multiplier.

†† This is the average of the averages of each road.

‡‡ This is obtained by multiplying the total cost of locomotive service per mile run on each road by the total number of miles run and adding the products together and dividing by the number of miles run on all the roads.

adversary and to our readers the question, whether a $115,000,000 fact has not "considerable" strength.

COAL CONSUMPTION.

The strong point which *The Engineer* has dwelt upon during the discussion of the relative merits of our locomotives and theirs has been the greater economy of their locomotives in the consumption of coal. From our tables it will be seen that the average consumption on British roads, for the half year covered by Table I, is 37.53 lbs. per engine mile, whereas on the American roads, of which the consumption is reported in column 9 of Table II, the average is 74.37, or almost exactly twice as much as that

TABLE III.—GREATEST ANNUAL MILEAGE OF LOCOMOTIVES ON DIFFERENT ROADS.

| | Miles. | Miles. | Miles. |
|---|---|---|---|
| Western New York & Pa | 51,269 | 50,572 | 50,157 |
| Chicago & Alton | 51,433 | 50,026 | 46,968 |
| Kansas City, Fort Scott & Gulf | 55,538 | 50,436 | 45,351 |
| Old Colony | 55,832 | 55,098 | 54,238 |
| Canadian Pacific | 57,156 | 56,466 | 56,399 |
| Mobile & Ohio | 59,000 | 48,446 | 44,289 |
| Wisconsin Central | 60,784 | 48,628 | 47,399 |
| Chicago, Milwaukee & St. Paul | 60,928 | 60,523 | 59,888 |
| Missouri, Kansas & Texas | 61,729 | 58,763 | 54,190 |
| Wabash | 61,785 | 59,625 | 57,823 |
| Delaware, Lackawanna & Western | 63,581 | 60,500 | 60,374 |
| Milwaukee, Lake Shore & Western | 65,750 | 63,660 | 61,970 |
| Illinois Central | 66,428 | 64,837 | 57,081 |
| Ohio and Mississippi | 16,498 | 65,200 | 64,349 |
| Manhattan Railway | 67,785 | 57,729 | 56,725 |
| Boston & Albany | 70,217 | 67,965 | 66,781 |
| Cincinnati, New Orleans & Texas Pacific | 70,356 | 67,850 | 66,857 |
| Chesapeake & Ohio | 71,084 | 50,053 | 49,756 |
| Burlington, Cedar Rapids & Northern | 71,630 | 51,980 | 51,360 |
| Pennsylvania (United Railroads of N. Jersey) | 74,268 | .... | .. ... |
| Michigan Central | 77,913 | 76,272 | 75,196 |
| Philadelphia & Erie | 79,868 | ...... | ... .. |
| Union Pacific | 80,198 | 79,650 | 73,763 |
| Fitchburg | 81,262 | 69,177 | 52,196 |
| Atchison, Topeka & Santa Fe | 83,076 | 81,243 | 73,919 |
| Lake Shore & Michigan Southern | 86,155 | 83,038 | 79,251 |
| Pittsburgh, Fort Wayne & Chicago | 86,240 | 84,642 | 81,854 |
| Pennsylvania (Philadelphia to Pittsburgh) | 86,635 | ...... | ...... |
| Missouri Pacific | 88,240 | 63,127 | 57,654 |
| Philadelphia, Wilmington & Baltimore | 91,680 | 88,044 | 84,576 |
| Louisville & Nashville | *96,541 | 88,904 | 87,909 |
| Chicago, Burlington & Quincy | 97,257 | 95,425 | 91,414 |
| New York, Central & Hudson River | 97,384 | 95,096 | 93,662 |
| Chicago & North Western | 99,207 | 87,299 | 69,633 |

* This engine was in service only nine months, and made this mileage in that time

of the British engines. If this consumption was of coal of the same quality, and in doing the same amount of work, and if the relative merits of locomotives depended entirely on the fuel consumption, it would, of course, be a bad showing for our engines.

With reference to the quality of American coal, we have taken occasion before to say that it varies within very wide limits. Through the courtesy of Mr. Leeds, Superintendent of Machinery of the Louisville & Nashville Railroad, we are able to give the relative consumption of 16 different kinds of coal, as determined by careful, practical tests in running passenger trains on that road. The comparison is made with good Pittsburgh coal, which was rated at 100. The consumption was as follows :

TABLE IV.—VALUE OF DIFFERENT KINDS OF COAL.

| | | |
|---|---|---|
| Coal No. 1. | Pittsburgh (good), Consumption | 100. |
| " " 2. | " " " | 109.79 |
| " " 3. | " " " | 112.84 |
| " " 4. | " " " | 117.05 |
| " " 5. | " " " | 124.33 |
| " " 6. | " " " | 125.03 |
| " " 7. | " " " | 128.84 |
| " " 8. | " " " | 129.75 |
| " " 9. | " " " | 131.21 |
| " " 10. | Pittsburgh (poor) " | 134.83 |
| " " 11. | " " " | 138.29 |
| " " 12. | " " " | 138.57 |
| " " 13. | " " " | 139 49 |
| " " 14. | " " " | 149.04 |
| " " 15. | " " " | 162.61 |
| " " 16. | " " " | 181.05 |

From this table it will be seen how widely the coal which is used in this country differs in quality and value. It is by no means certain that the poorest coal tested by Mr. Leeds is the worst that is used, as he only experimented with fuel available for his own road. Evidently it would be idle to expect that an engine using the No. 16 coal would burn as little per mile as another would which used " good Pittsburgh."

We have no direct testimony bearing upon the relative value of English and American coals, but all the information received from persons who have had experience, both here and in England, is to the effect that the coal used there is much better than the average here, especially better than that used in our Western States. In 1844 Professor Johnson made a series of elaborate tests on coals for the Secretary of the U. S. Navy. These were probably the most complete experiments ever made on American coals. He also tested a few samples of English and Scotch coals. Without going into minute fractions his conclusions may be summarized by the following figures :

| | |
|---|---|
| Water evaporated per lb. of Scotch coal | $6\frac{1}{8}$ lbs. |
| " " " " " Liverpool (England) | 7 " |
| " " " " " Pittsburgh (Pa.) | 7 " |
| " " " " " Newcastle (England) | $7\frac{3}{4}$ " |
| " " " " " Cumberland (Md. and Pa.) | $8\frac{1}{2}$ " |

These figures give some idea of the relative value of these different coals. It should be added that Pittsburgh and Cumberland coals are among the best in this country for steam generating purposes. All Western coals are of poorer qualities, descending almost to incombustibility.

The impossibility of making any comparison which will be conclusive of the relative economy of locomotives using fuel varying so widely in quality as that which is used on English engines and in this country must be obvious.

From Table I it will be seen that the consumption on the Scottish roads averages 46.04 lbs. per mile, or nearly 30 per cent. more than on English lines, with the probability, too, that trains in Scotland are lighter than in England. This is due to a great extent, probably, to the poor quality of the coal used there.

In our next article we will make some comparison of the loads hauled on British and American railroads, and of the relative cost of repairs in the two countries, and also of the cost of locomotive service per ton of train hauled per mile.

(TO BE CONTINUED.)

## AFRICAN TRANSCONTINENTAL RAILROADS.

THE French engineer is nothing if not comprehensive and general in his plans : and accordingly M. Beau de Rochas, in advocating the building of the Trans-Saharan Railroad, has outlined a system of great African lines.

The Trans-Saharan line, according to M. de Rochas, should be considered not only as a connection between France and its commercial colonies and outposts in the Western Soudan and Senegambia, but as part of a transcontinental route which will shorten by nearly one-half the time of transit between French ports and the greater part of South America. The road to be built by France should not be merely the Trans-Saharan ; it should be the Western Trans-African, and should have its northern termini at the ports of Oran and Djidjelli in Algiers and its southern at Rio Nuñez on the Senegambian coast. Now the shortest possible line across the Atlantic between America and the Eastern Continents is one drawn from Cape San Roque or the port of Pernambuco near by, to Rio Nuñez. Even at the moderate speed of 13 or 14 knots an hour the ocean can be crossed there in $5\frac{1}{2}$ days, while at 19 or 20 knots the time would be less than four days. But if we adopt the lower speed, the voyage from Pernambuco to Marseilles,

the proposed railroad being completed, could be made in nine days, as against 16 or 17 now required. For freight, allowing for transfer and the slower speed of freight trains, the gain in time would be three or four days; to this must be added the diminished risk, lower insurance and other considerations.

Whether passengers might not prefer the longer sea voyage to a ride of three or four days by rail through the heats of equatorial Africa, with risks of disease, M. de Rochas does not consider worth serious treatment, in view of the unquestioned saving in time.

Pernambuco has already rail connections with a considerable part of Brazil, and with the European line once established these will be extended until the city becomes the central point to which all the railroad systems of South America will converge. Two leading lines may be indicated; one through the Amazon Valley to Bolivia and Peru, the other leading directly to Valparaiso.

In support of this comprehensive plan a political reason is brought forward, which is perhaps best expressed in M. de Rochas' own words:

> The North Americans do not conceal their purpose of extending the Monroe Doctrine to South America. But between the North Americans and the South Americans there is nothing in common but the American name. The South American is of the Latin Race. That race does not wish, it cannot, it has no right to permit itself to be absorbed by any other. Its vitality extends through the whole Latin world; and in drawing its lines of relationship closer, it will raise still higher its historical standard.
>
> Now, the Western Trans-African Railroad, if it existed, would become—it must necessarily become—the bond of union between the Latin world on this side and on the other side of the Atlantic. The Latin world, and with it civilization, of which it is the highest and best representative, have everything to gain by this closer connection.

This is a peculiarly French view of the subject, to which some exceptions might be taken here, did space permit.

The plans of M. de Rochas will be made clearer by the accompanying sketch, on which the West African line and its American connections are shown at a glance.

But the West African line is not the only one included, although it is the first to be built. Near the southern line of the Sahara another transcontinental line will diverge and run through the Eastern Soudan and across the headwaters of the Nile to a point near Cape Guardafui, from which a comparatively short sea voyage will be required to reach the ports of India and China. This built, the tedious voyage through the Red Sea and the Suez Canal is a thing of the past.

Still another branch from a point in the Central Soudan to the East African Coast at Mozambique or the mouth of the Zambesi will furnish a short line to Australia and New Zealand. Here, then, we have a system which will revolutionize the commerce of the world and turn the entire trade of the East into new channels. Far-reaching as were the results which followed the opening of our own Pacific railroads, they will be small when compared with those attending the completion of the African Trans-continental.

The commercial center of the world will be transferred from London to Marseilles. Liverpool and New York will become seaports of merely local importance.

Some difficulties will attend the building of the great African lines; but, after all, the plan of M. de Rochas appears to us no more visionary and extravagant than that of the American transcontinental did to our fathers only 40 years ago. No one will now venture to predict what projected lines will or will not be in operation in 1930.

AFRICAN TRANSCONTINENTAL LINES.

## NEW PUBLICATIONS.

BRAZIL. BULLETIN NO. 7 OF THE BUREAU OF THE AMERICAN REPUBLICS. Washington; issued by the Bureau.

The Bureau of the American Republics is one of the results of the Pan-American Congress of last year, and its object is to promote friendly feeling and to increase the knowledge of our sister republics in this country. The present monograph on Brazil is a volume of 336 pages, containing a large amount of information in relation to that country. It includes historical sketches; an account of the commercial and political geography; colonization and immigration; the mineral agricultural and forest resources; railroad and other transportation systems; financial and political systems; commercial arrangements with the United States; commercial statistics; tariffs, and a commercial directory. It is illustrated by a map of the country and a number of views of the chief cities.

The book is a valuable one to all who are interested in Brazil, or who hope to secure a share of the trade with that country. It is also interesting to the general reader. Our knowledge of South America, even among reading people, is much less full and accurate than it should be, and the publications of the Bureau are serving an excellent purpose in increasing it. The

work entrusted to it is an excellent one, and has so far been carried on with excellent judgment.

Poor's Directory of Railroad Officials and Manual of American Street Railroads: 1891. H. V. & H. W. Poor, New York; price, $2.

This is a supplement to *Poor's Manual*, and is intended to give more complete lists of railroad officers than can be inserted in the *Manual* without increasing too much the bulk of that work. It is also very serviceable for those who need only the names of officers and do not require the detailed information found in the other book.

The *Directory* contains lists of all the officers of steam railroads in the United States, with special lists of those in charge of the operating and mechanical departments, and of purchasing agents. It also gives the statements of the street railroads of the country; finally it has a directory of the railroads in Mexico, Central America, South America, the West Indies, and the Hawaiian Islands; all countries which have a close relation to this.

The work on this book has been done as carefully as that on the *Manual*, and its accuracy may be generally relied on. That it is indispensable for all who have business with railroads, it is hardly necessary to say.

Builders' Hardware. *A Manual for Architects, Builders and House Furnishers.* By Clarence H. Blackall, Architect. Ticknor & Company, Boston; price, $5.

At first sight this might be taken, from its title, to be a trade catalogue; but an inspection of its contents will show that it is something quite different. The term "Builders' Hardware" is defined by the author as including "metal-work of every description entering into the construction and finish of a modern building, from the nails and bolts used in the rough work to the door furniture and brass lock and plate work of the finish."

This is certainly comprehensive enough; and that the book has been made to cover the subject as defined, an inspection of the table of contents and the index will show. In fact, any one not familiar with the subject will look with some wonder at the great number and variety of the articles described and mentioned.

The book has been written chiefly for architects, with a view of enabling them to make out their specifications with a better and clearer understanding of the minor details of the metal work, and of what is required in that line in a good building than most of them, who have not had practical experience as builders, can be expected to possess. In this way it may be considered a very useful book. As far as manufactures are concerned, the author seems free from bias of any kind, unless a little, and perhaps natural leaning toward Boston practice may be so considered. His judgments as to quality of work are apparently quite impartial.

The numerous illustrations have purposely been made as simple as possible; they are very good of their kind. A few more elaborate and very handsome plates are added, giving examples of artistic finishings for the higher grades of house work. The book is an admirable specimen of typographical work.

Report of the Proceedings of the Twenty-fifth Annual Convention of the Master Car-Builders' Association. *Held at Cape May, N. J., June* 9, 10, *and* 11, 1891. Chicago; published by the Association, John W. Cloud, Secretary.

This report of the Master Car-Builders' Convention follows close upon that of the Master Mechanics, a little delay being required to enable the Secretary to include in it the results of the letter-ballots ordered by the Convention. Like that of the other Association, the Convention this year had no questions of special importance before it, those which called out the most discussion being in relation to air-brake standards and repairs and inspection of freight cars fitted with air-brakes. These are comparatively new matters, and are growing in importance as the use of continuous brakes on freight trains is increasing.

The Report is carefully edited, and printed in the usual style. It has also the supplements containing the Rules of Interchange, the Standards of the Association, and Decisions of the Arbitration Committee. These alone make it valuable to officers of the car department, apart from the interest attaching to the reports and discussions.

Poor's Handbook of Investment Securities. *Second Annual Number for* 1891. H. V. & H. W. Poor, New York; price, $2.50.

Like the *Directory*, this book is intended as a supplement to *Poor's Manual*, and is especially for the use of bankers and banks, investors, and those who deal in or invest their capital in railroad securities. It contains lists of bond coupons, time and place of payment; times and places of annual meetings and payment of dividends; locations of general and transfer offices; ranges of stock and bond prices for the past year; dates of maturity of bonds; a condensed abstract of railroad returns from the *Manual*, and much other information of the kind which dealers and investors need for reference. In addition to the railroad information, there are lists of State, county, and municipal bonds, and of the securities of a number of miscellaneous corporations which are largely bought and sold.

Judging by past issues, the work is generally accurate and reliable, and the constant use of the preceding number has shown its excellence. It may also be said that it is the only work of the kind which is to be had.

A Treatise on Wooden Trestle Bridges According to the Present Practice on American Railroads. By Wolcott C. Foster. John Wiley & Sons, New York; price, $5.

This is a book on a subject concerning which a great deal has been written in a detached way—in papers and society proceedings and the like—but on which, until recently, there has been no connected treatise. That it is an important one, the author's figures show, if they are correct—and they are probably very nearly so—for he estimates that there are about 2,400 miles of wooden trestle in the United States, of which about one-quarter is only temporary, to be replaced by embankment, while probably one-third more will be replaced by iron. This would leave between 800 and 1,000 miles of what may be called permanent wooden structures, to take no account of the new ones which are constantly going up on new lines. Taking an approximation to the average cost, the 2,400 miles of trestle must have cost over $76,000,000, a sufficiently formidable sum.

Mr. Foster has aimed to give the methods of construction which are approved by general adoption, and to describe the practice on the best roads, and he has collected a large amount of information which will be of service to engineers in railroad work.

After the introduction the book has several chapters on general subjects, such as Pile-bents, Framed Bents, Pile-drivers, Floor Systems, Bracing, Iron Work, etc. There are also chapters on Erecting, on Specifications, on Bills of Material, and on Maintenance. These are followed by drawings and bills of material for eight pile trestles and 23 framed trestles, taken from actual practice on different roads, and including some bridges of extraordinary height; it may be said, in fact, that almost every sort of trestle is included.

The drawings are generally good, but in one or two cases they are too much reduced—notably in the case of those of the pile-driver car on pages 16, 17, 18, and 19, where the figures

are so small they can hardly be read without a microscope. It may also be said that though the letter-press is clear and good, the cuts are not as well printed as they ought to be in such a book.

These are minor points, however, and the book may be considered a useful addition to engineering literature.

NOTES ON MILITARY SCIENCE AND THE ART OF WAR. By Joseph M. Califf, First Lieutenant Third U. S. Artillery. *Second Edition, Revised and Enlarged.* (James J. Chapman, Washington; price, $1.)

The author of this book, who is well known to readers of the JOURNAL, prepared it originally while detailed as professor at the State University of Iowa, with the intention of supplying a text book which was much needed to supplement his lectures. It is not intended to teach the purely technical part of the military profession, but to give a general idea of the organization of an army and the manner in which it is handled, supplied and made efficient in time of war; of the weapons with which it is armed and of the manner of using them, with some lessons drawn from the great captains of the past.

Among the subjects treated are Army Organization and Administration; Lines and Orders of Battle; the Systems of Frederick and Napoleon; Modern Tactics and Strategy; Explosives, Guns, Projectiles and Torpedoes; Fortification and Sieges; Military Transport and Supply; Outposts and Reconnaissances; Management of Troops in Campaign and Military Law.

As a text-book it is excellent. The different subjects are necessarily treated in a general way, but the explanations are clear and plain, and the style is excellent. It is, in fact, somewhat more than a text-book, and is a very good work for the general reader who wishes for a general knowledge of military methods. It is sufficiently illustrated where diagrams are needed to make the subject clear.

The present edition has been largely rewritten in order to keep up with the recent rapid progress in small arms, cannon, powders and other military material. Chapters on Transport and Reconnaissance have also been added, with some account of the systems of outposts and advanced guards adopted in foreign armies.

## TRADE CATALOGUES.

*About Warming Railroad Cars. The Leland Car Heater & Steam Coupler Company, New York.*

This is an illustrated description of the Leland Heater, which is a device for heating railroad cars by a circulation of water which has been heated by steam from the train pipes. This heater is in use on the Wagner sleeping and parlor cars, and is being put in a number of cars of the New York, New Haven & Hartford Railroad.

*Industrial Railways (Synopsis). The C. W. Hunt Company, New York.*

*Coal Machinery (Synopsis). The C. W. Hunt Company, New York.*

*Manila Rope. The C. W. Hunt Company, New York.*

The first of these catalogues contains a very good illustrated description of the Hunt Company's system of light railroads for factories, yards, and similar purposes. This system—which has already been described in the JOURNAL—presents many advantages, and has been adopted by a number of large factories.

The second is in part a repetition of the first, but it also describes the Hunt machinery for unloading, handling, and loading coal on a large scale. This machinery has reduced the cost of handling coal to a very low figure, and has also brought down the time required for disposing of a cargo to almost the lowest possible point.

The third catalogue might almost be called a short treatise on Rope, and it contains much interesting information on the making and uses of the best quality of rope, the latter including its use in transmitting power. Like the others, it is well illustrated.

*Catalogue, Dodd's Sigmoidal Water Wheel. The Pacific Iron Works, San Francisco.*

## BOOKS RECEIVED.

*Irrigation Statistics of the Territory of Utah.* Compiled by Charles L. Stevenson, Secretary of Utah Statistics Committee. This is a valuable compendium, specially prepared for the Irrigation Congress at Salt Lake.

*Cornell University, Agricultural Experiment Station: Bulletin* 31. Ithaca, N. Y.; published by the University.

*Tide Tables for the Atlantic Coast of the United States for the Year* 1892. Washington; Government Printing Office. The United States Coast and Geodetic Survey, by which these Tables are prepared, desires to call attention to the fact that copies can be obtained at 25 cents each. Agencies for their sale are established in all the principal seaboard cities.

*Proceedings of the Engineers' Club of Philadelphia: Volume VIII, No. 3, July,* 1891. Philadelphia; published by the Club.

## ABOUT BOOKS AND PERIODICALS.

READERS will find in the OVERLAND MONTHLY for October a very interesting description of the new Leland Stanford University, its foundation and objects. Other articles are on the Fruit Canning Industry in California; the first Public School in California; the Chinese Army, and the Olive in America. The last-named paper shows the possibilities of olive culture and the extent to which it has been undertaken on the Pacific Coast. Besides the articles named there are several short stories and sketches, some of them very good.

Perhaps the more striking articles in the ECLECTIC for October are Sir Alfred Lyall's on Frontiers, from the *Nineteenth Century*; Mr. Christie Murray's on Australia, from the *Contemporary Review*; Colonel Knollys' on the Diamond Mines of South Africa, from *Blackwood's Magazine*, and one on Electrical Evaporation, from the *Saturday Review*. Other articles given in this number are from *Temple Bar*, the *Westminster Review*, the *Fortnightly Review*, the *New Review*, the *National Review*, the *Spectator*, and the *Athenæum*, showing a wide range of choice.

The September number of the BULLETIN of the American Geographical Society has papers on the Native Copper of Michigan, by E. B. Hinsdale; on the Flooding of the Colorado Desert, by B. A. Cecil Stephens; on Northern Mexico, by Carl Lumholtz, and very careful reviews, by George C. Hurlbut, of Büttikoffer's Liberia and Garcia Cubas' Mexico. The Notes include an account of the International Geographical Congress at Berne.

Among the topics discussed in the ARENA for October are Healing through the Mind; Weak Spots in the French Republic; Leaderless Mobs; Theosophy; Nationalism, and the Microscope. This list does not include all the articles, but only the leading ones. No other magazine discusses such topics or with so much freedom as this, which has well earned its name.

In the COMPASS for October there are articles on Linear Measurements in the Field, on the Plain Transit, on Instrument Adjustments, and on Speedy Calculators. The very

interesting article on Series of Numbers is continued, the present part showing the application of the principles treated in the article in the slide-rule.

The paper formerly known as the *Journal of Car Heating* has taken a new departure, and will hereafter be known as the RAILROAD CAR JOURNAL. Its field will be somewhat extended, as expressed in the new title, and will include the construction and operation of cars, as well as their heating and lighting. It is a well-edited paper, and the October number—the first under the new name—presents much interesting matter. We wish our contemporary all success.

Among the books now in preparation by John Wiley & Sons, New York, are the MANUAL OF MINING, by Professor M. C. Ihlseng, of Golden, Col., a high authority. The same firm have also in hand Mr. J. G. A. Meyer's book on MODERN LOCOMOTIVE CONSTRUCTION, an enlargement of the articles published in the *American Machinist* last year.

The POPULAR SCIENCE MONTHLY for November contains Mr. Durfee's final paper on the Manufacture of Steel. Mr. Carroll D. Wright continues his Lessons from the Census, and Professor Goodale tells of some of the possibilities of Economic Botany. Professor Henderson's paper on University Extension describes the latest educational movement of importance.

Among the books announced for early publication by Harper & Brothers, New York, are Mr. Theodore Child's SPANISH AMERICAN REPUBLICS. The papers by Mr. Child in *Harper's Magazine* attracted much attention, and in book form they will be of permanent value. Another work, which will interest military men, is the WRITINGS AND MEMOIRS of Field Marshal Von Moltke, prepared from the voluminous records left by the great soldiers.

The Mississippi National Guard is described by Lieutenant R. K. Evans in OUTING for October. The Indian Territory, the Pacific Coast, the Eastern Seaboard, the Upper Peninsula of Michigan, and the Rocky Mountains all find place in its articles of travel and sport. No magazine has made so great an improvement in its illustrations recently as OUTING, both in number and quality. In the October number—in Studies in Black—there are three cuts which are by far the best representations of negro children we have ever seen in print; and there are other illustrations which deserve special commendation.

The NORTHWESTERN MECHANIC, published in Minneapolis, has been transferred to Messrs. Cooper & Hampton, who propose to make it a journal which will record the progress of mechanical engineering generally, following no special field. With the change many improvements are to be made.

The LOCOMOTIVE ENGINEER, which has been for some time issued by the *American Machinist* Publishing Company, has been sold by that Company to Messrs. Angus Sinclair and John A. Hill. Mr. Hill has been connected with the paper for some time, and Mr. Sinclair is well known as Editor of the *National Car-Builder* and Secretary of the Master Mechanics' Association. The LOCOMOTIVE ENGINEER has always been an excellent paper, bright and lively, and under the new management it cannot fail to improve.

The final article of the Steamship Series in SCRIBNER'S MAGAZINE appears in the November number; it is by John H. Gould, and is on the Ocean Steamer as a Freight Carrier. The French Trans-Saharian project is described in another paper by M. Napoleon Ney, and Lieutenant A. B. Wyckoff writes of the Naval Apprentice System. Among other articles are papers by Mr. Carl Lumholtz on his explorations in the Sierra Madre in Mexico, and by Alfred Deakin on the Federation of Australia.

In the number of HARPER'S WEEKLY for October 3 there was an illustrated description of the opening of the St. Clair Tunnel; also of some of the sailing ships of large carrying capacity lately built. The previous number had an interesting account of the cable road on Broadway in New York. In the issue for October 10 the work of the Agricultural Department's rainmakers in the Southwest is described and illustrated, and there is also an account of the improvements in progress in the Delaware River navigation. In the number for October 17 the French cod fisheries in Newfoundland are illustrated.

## SOME CURRENT NOTES.

SINCE the article in the October number of the JOURNAL (page 455), on the increased strength obtained by oil-tempering and annealing steel forgings, was published, we have received particulars of another test. In this case a steel crank-pin was taken, the chemical analysis being as follows: Carbon, 0.050; manganese, 0.060; silicon, 0.150; phosphorus, 0.035. A specimen ½ in. in diameter and 2 in. between marks, cut longitudinally from the pin, after treatment stood the following tests: Tensile strength, 112,040 lbs.; elastic limit, 61,170 lbs.; elongation, 20.55 per cent.; contraction of area, 45.53 per cent. These are notable results.

THE Committee on Safety Appliances appointed at the last yearly Convention of Railroad Commissioners will hold a meeting November 10 next, at 10 A.M., in the rooms of the Chamber of Commerce, No. 34 Nassau Street, New York, to consider the subject of safety appliances, in accordance with the resolutions adopted at the Convention, which instructed the Committee to urge upon Congress the need of legislation for the adoption of uniform safety couplers and train brakes.

The Committee specially request that all organizations of railroad employés and officials have representatives present to give their views on the subject of Federal regulation of safety appliances on railroads.

The Committee consists of the following Commissioners: George C. Crocker, of Massachusetts; James C. Hill, of Virginia; Spencer Smith, of Iowa; William E. Rogers, of New York; John H. King, of South Dakota. The Secretary is Mr. Edward A. Moseley, of the Interstate Commerce Commission.

ONE of the largest relief maps in the world has been prepared by Professor Edwin E. Howell, of Washington, from data furnished by the United States Coast and Geodetic Survey. It represents the United States, and is molded on a section of a globe 133 ft. in diameter; the map itself is 6 ft. 6 in. × 4 ft. in size. The horizontal scale is 1 in. = 50 miles, and the vertical scale 1 in. = 5 miles.

WORK is to be actually begun on the first elevated railroad in Philadelphia intended solely for city travel. This is the Northeastern Line, which is to run from Market Street northward to Frankford. A contract has been let for the building of the road from Market Street to the corner of Amber and Norris, and bids are in for the rest. The structure will be similar to the Sixth Avenue Line in New York, the tracks being carried on girders extending across the street and resting on pillars placed at the edge of the sidewalk. The Phœnix Bridge Company is to build the road.

AN important dam across the Androscoggin River at Rumford Falls, Me., has just been completed. Its object is to improve the water-power at that point. This dam is 440 ft. long, 56 ft. wide at the bottom, and about 20 ft. high. It is built of large timbers laid up in crib-work and the cribs filled with stones and covered with 4-in. hardwood plank. On the up-stream side the structure is covered with gravel, and on the down-stream side it is protected by a broad apron of heavy planking. The headgates are set in masonry.

ONE of the largest irrigation systems in this country is in the Pecos Valley in New Mexico. It already includes 120 miles of main canals and 100 miles of laterals, and plans have been prepared for extensions which will irrigate 160,000 acres of land. The water is taken from the Pecos River and the Rio Hondo, and a large storage reservoir has been established on the Pecos, where a lake seven miles long, 1¾ miles wide, and holding about 1,000,000,000 cub. ft. of water has been formed. The dam here is 40 ft. high, 175 ft. wide at the base, and 1,140 ft. long. It is chiefly of limestone and has on the upper face a layer of earth 6 ft. thick, covered with riprap. The main canal from this reservoir is 7 ft. deep, 45 ft. wide at bottom and 70 ft. at the top.

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SOME important tests are in progress at the Army proving ground at Sandy Hook. They include those of the 10-in. guns, of the new mortars, and of the pneumatic disappearing carriage for the 10-in. gun. The greatest delay in the trials so far has been caused by the difficulty in getting a full supply of powder.

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THE proposed tests of American steel armor-plates have been delayed a little by lateness in delivery, but are expected to be made in November. One object will be to determine the advantages of nickel alloy in steel and of the Harvey process of treatment.

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IT is now stated that Mr. Edison has devised a new electric motor, which will do away with the objectionable overhead wire entirely, the electrical current being sent through the rails. We are also told that this motor can be applied on long lines, and a speed of at least 100 miles an hour is promised us. Mr. Edison hopes soon to be ready to test this motor in actual service.

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THE total freight movement through the Sault Ste. Marie Canal in September was 1,388,333 tons, showing an increase of 8¾ per cent. over September, 1890, notwithstanding the fact that there was a decrease of 10 per cent. in the iron ore traffic. The variety of the traffic will be seen from the statement that the leading items of freight were 621,316 tons of iron ore, 351,517 tons of coal, 548,115 barrels of flour, and 5,928,840 bushels of wheat.

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ON October 1, according to the tables of the *American Manufacturer*, there were 305 furnaces in blast having a weekly capacity of 180,818 tons; an increase of 1 per cent. in number of furnaces, and of 3½ per cent. in capacity during the month. As compared with October 1, 1890, there was a decrease in the number of furnaces at work, but an increase of 4,035 tons, or 2¼ per cent., in capacity. The increase has been largely in Southern furnaces.

THE water has been let into the second section of the Manchester Ship Canal, extending from Ellesmere Port to the mouth of the River Weaver, a distance of seven miles. There is now a waterway in the canal for 11 miles, from Westham Marsh locks to the Weaver River, and vessels bound for the upper Mersey pass through it. The accompanying sketch, from *Industries*, shows the completed


portion of the canal, which is shaded in the plan, the unfinished portion being also shown, unshaded. On the incomplete sections, however, a large part of the work has been done.

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THE reports of the consulting engineers of the New York Rapid Transit Commission have been made public. The engineers—Messrs. Octave Chanute, John Bogart, Theodore Cooper, and Joseph M. Wilson—present separate reports, none of them fully approving either of the plans before the Commission. Mr. Chanute's report, which is especially full and minute, recommends a combination of the parallel and separate tunnel plans, with some changes to secure greater facilities in operating the proposed lines.

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THE race between the steam launches *Norwood* and *Vamoose*—for each of which the claim to be the fastest vessel in the world has been put forward—has been postponed on account of an accident to the *Norwood*, so that the question of their respective speed must remain undecided for the present. Both boats are simply racing machines, being of no use even for pleasure boats, since the engines and boilers occupy all the available space, so that the contest between them will be of no practical service—except, perhaps, to show how great a weight of machinery a small boat can be made to carry.

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SOME carefully prepared statements as to the cost of operating street railroads were submitted to the Street Railroad Association recently. According to these, the cost of carrying each passenger—taking the average of a number of roads of each class—was 3.55 cents with electric motors; 4.18 cents with horses, and 3.22 cents on cable roads. Including interest on cost of road, the averages were: On electric roads, 4.53 cents; with horses, 4.98 cents; on cable roads, 4.77 cents. The great difference is on the cable roads, when interest charges on a costly plant are included. That a cable road is by far the highest in first cost every one knows; that it is not the best fitted for a city where there is large traffic, many will be disposed to doubt.

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THE London *Iron* says that the firm of Esscher, Wyss & Company, of Zurich, Switzerland, have completed a launch 20 ft. long and 5 ft. wide, driven by a 2-H.P. naphtha motor. The peculiarity of this boat is that she is built entirely of aluminum, even to the engines and propeller, being the first vessel in the world so constructed. She has made one or two successful trial trips.

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THE railroads of the Argentine Republic are in a bad condition, owing to the general depression of business in that country, and in part also to the refusal of foreign boards of directors to reduce rates or accommodate the management in any way to the present state of affairs. Under these conditions the Government is already called upon to make large payments under the guarantees given to some of the companies, while further sums will soon be required. The foreign control of the roads is really proving at present a serious injury, both to the country and to the railroads themselves.

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IN the Columbian Exhibition at Chicago England and Germany have each secured an equal space, 40,000 sq. ft., for machinery exhibits.

The Illinois exhibit will include a number of topographical maps, specially prepared for this purpose. One will show the water-courses and another the railroads, in addition to the general topography.

The old Hackworth engine *Samson*, now in Nova Scotia, will be in the Department of Transportation, with a facsimile of a passenger car of 1832.

Mr. Willard A. Smith made an excellent address in behalf of the Transportation exhibit before the Superintendent's Association.

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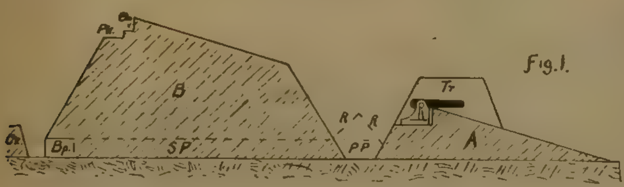
## RAPID TRANSIT IN NEW YORK.

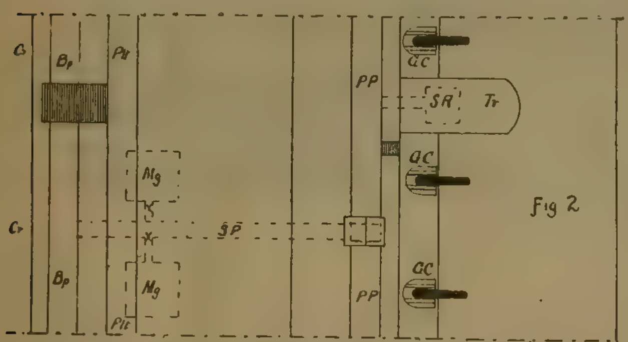
THE Rapid Transit Commissioners—Messrs. William Steinway, John H. Starin, Samuel Spencer, John H. Inman and Eugene L. Bushe—who have been considering the question of new passenger lines in New York for some months, made their report public on October 20. As anticipated by previous partial statements, it recommends a line from the Battery northward under Broadway to Union Square (14th Street), where this main trunk is to divide, the western branch proceeding under Broadway

out their reasons, and have therefrom deduced a plan of works, which seems to me to give the result desired, viz: The minimum of exposure to the gun while not decreasing the efficiency of its fire. The materials employed in construction are always and everywhere accessible, being either sand or clay, whichever may be most convenient.

I consider that the essential points to be attained are: First, to mask the gun, and second, to stop the shot of the enemy. I make no attempt to secure a plunging fire, since the great range of modern guns renders the attainment of this object impracticable where the ships have open water and the beach is flat; and these are the conditions at most of the locations where works are needed.

In this article I show only the general plan. The details must be determined by experiment. I have no means of ascertaining the depth to which a modern gun will penetrate sand or clay, and the proportions of the works depend upon this factor. The works should be thick enough to stop a shot fired from any distance at which a fleet is likely to engage. The plan is drawn with an angle of slope of 15°, which gives a proportion of height to base of about 5 to 19, or an elevation of about 25 in a distance of




95 ft. Greater thickness can be secured either by diminishing the angle of slope or by increasing the height of the works.

As shown in the plan, the proposed fortifications consist of two lines of works, *A* and *B*, separated by a protected passage-way, *P P*, which should be wide enough to allow the use of carts and wagons. The outer line *A* is for the guns which are mounted in *barbette*. The inner line *B* is designed to mask the guns, to stop the shot of the enemy, and prevent them from penetrating to the interior of the fort, and to afford protection to the guns in case of an assault.

On the outer works are the gun-chambers *G C*, armed with one, two, or three guns each, as circumstances make most advisable. The chambers are separated by traverses, *T r*, to protect the guns from a flank fire. The closer together and the longer the traverses the greater the protection they afford the guns, and the less the lateral range. The proper size and interval must be determined by the requirements in the case of each particular gun. Under the traverses may be constructed shot-rooms *S R*, which may be on the level of and open into either the protected passage *P P*, as shown in the plan, or the gun-chamber at the corner next the revetment. The shot-rooms and revetments should be faced on the inner side with soft iron plates or other material which will not splinter, and which will hold back the sand and prevent it from running out of place.

The inner line *B* is much thicker and higher. The slopes of the two lines are in the same straight line, to render the fire of the defense more effective in case of an assault upon the guns. Sally-ports *S P*, wherever needed, afford a communication between the interior of the fort and the protected passage *P P*. At the outer end of the sally-ports a steep ridge roof, shown by the heavy dotted line *R R*, crosses the passage, so steep as not to be available as a bridge for assaulting troops. There are sliding-doors to run across the passage and close the sally-port. These doors are pierced with loop-holes for rapid-fire guns, to sweep the passage. The eaves of the roof should project 2 ft. or 3 ft. to prevent sand, dislodged by shell and falling into the passage, from hindering the easy running out of the doors.

Under the crest of the inner line are situated the magazines, *M g*, communicating with the sally-ports by narrow passages *x*. A bomb-proof, *B p*, to shelter the troops is constructed along the bottom of the inner line, and is covered in reverse by curtains *C r*, thus affording ample and thorough protection to the troops when not in action. The crest of the inner line is fashioned into a platform, *P l t*, furnished with a Berm, *B m*, for the use of infantry and rapid-fire guns. As this crest is higher than the tops of the traverses, the approach to the works is completely swept by the repeating rifles and Gatling guns until the assaulting columns arrive at the foot of the slope, thus making it almost impossible for the enemy to carry the heavy guns. Should they do so, however, they cannot turn them against the fort, which is protected by the massive inner line, and their further progress must be made by crossing the protected passage swept by rapid-fire guns from the sally-port doors, scaling the inner line and charging up its slope in face of the garrison and their rifles, protected by the revetment of the inner line.

The heavy line behind the guns effectually masks them from an enemy at a little distance from the works. The gunner must direct his fire by the traverses. The shot plunges into the sand, leaving no trace visible at action distance by which the marksman can tell the error of his aim. The defenders are in danger only from those shots that strike at or very near a crest; and every gunner knows that a horizontal line is very hard to hit, especially when the marksman cannot tell whether he has aimed too high or too low. If the sand is thick enough, the garrison is as safe in its bomb-proof as if no enemy was in sight. The infantry platform is left unoccupied until the enemy arrives within range, and then it is manned in a very few seconds by means of the broad flights of stairs from the interior, and the rifles and Gatling guns are high enough to play upon the foe over the heads of the troops that man the heavy guns.

This plan seems to me to solve the problem with which I set out, and to afford the minimum of exposure with the maximum of efficiency. Of course the works will be stronger and the fire more effective when the fort can be located upon a hill or bluff, but this will generally be impossible on our coast. The first consideration must, of course, be to locate the works where they will most effectually command the approaches. A fort thus constructed and armed with effective guns ought to prove a formidable obstacle in the way of an attacking fleet, even of the heaviest iron-clads.

Our present stone forts can be converted into works of this description by facing the stone wall with a sufficient thickness of sand, and building the comparatively low gun-works outside of the line thus converted.

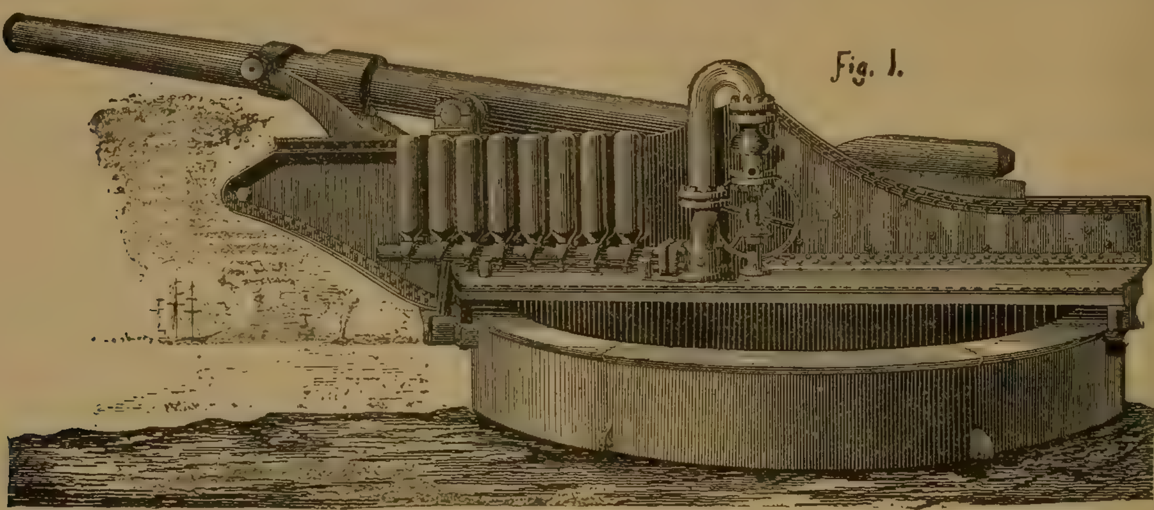
The terrific force of the 110-ton gun, given in the September number of the JOURNAL, would make it appear impracticable to erect any works that would stop such a projectile. But it should be remembered that experiment distance and action distance are two very different things. No ship is going to haul into point blank range of first-class guns. And at any range, the guns being equal, the ship is much more vulnerable than the earthworks. To damage the fort materially a gun must be struck, while nothing that floats can carry armor enough to keep out such a shot; to strike the ship anywhere is to damage her. The ship has a stationary and the fort a moving object to aim at, but this advantage is more than counterbalanced by the fact that one has a gun muzzle and the other a large man-of-war for a mark.

If thought advisable to give the guns more thorough protection when not in action, they might be mounted on

*chassis* so arranged as to run upon a track parallel with the revetment. This track could run into bomb-proofs constructed under the traverses at the inner end, and the guns could be kept under this cover except when their fire was needed. This would involve the necessity of very thick traverses. As a further safeguard the traverses might terminate in a sharp edge and be protected by armor strong enough to cause a shot to glance. This would, I think, be an easier and more effective way to protect the guns than mounting them on elevating carriages, although there would be plenty of room for the pits of the latter under the gun-chambers, if it be thought that this would be a better way to shield them from danger.

The advantages claimed for this plan are :

1. That it as effectually provides for the protection of the guns as is practicable without impairing their efficiency in action.




THE NEW GRAYDON DYNAMITE GUN.

2. That the guns cannot be turned against the fort.

3. The garrison is absolutely safe when not immediately engaged in action.

4. The guns and the approaches to the fort are completely covered by the fire of the supporting troops.

5. The use of the rifles and rapid-fire guns in no way interferes with the service of the heavy battery, the two lines being independent of each other, and neither interfering in any respect with the other.

6. Nothing in the plan prevents the use of armor-shields or other additional protection to the guns.

7. A successful assault upon the works is rendered almost an impossibility, on account of the thorough command of the approaches by the small guns and rifles from the platform of the inner line.

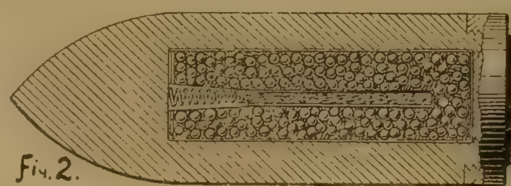
## THE GRAYDON DYNAMITE GUN.

It will be remembered that some time ago experiments were made by Lieutenant Graydon with a gun intended to throw shells containing dynamite or some other high explosive with ordinary powder. The result was not altogether favorable, and Lieutenant Graydon has since prepared plans for a gun to be operated by compressed air. One of these is to be constructed abroad, and the accompanying illustrations from *Le Genie Civil* show the plan which he has adopted. Fig. 1 shows the gun carried upon a circular mount. The gun shown is intended to carry a shell charged with dynamite, and is expected to have a range of about three miles.

The gun itself is a tube of Whitworth forged steel weighing about 11 tons. It is mounted, as shown, on a carriage working on rollers on a circular track. The gun itself is provided with trunnions through a circular opening in which the compressed air is admitted. Near the mouth of the gun is a steel collar carrying two additional trunnions, which are held by two forged steel levers ; and by means of these levers the elevation of the gun is altered at will, as they are worked by a hydraulic cylinder placed underneath the carriage.

The breech is closed by a screw with interrupted threads similar to those in use in the ordinary breech-loading gun. The loading is effected in any position by a small carrier mounted upon the rear of the gun carriage. This carrier is worked by two hydraulic cylinders, the cylinders being placed one on each side of the piece. By opening a valve the carrier with the shell is brought down into line with the axis of the gun, and, the two pistons continuing their movement, thrusts the shell forward into place and at the same time bring the breech screw into position.

The compressed air reservoirs are 32 in number and are disposed in groups of four on either side of the carriage, one group of them being shown outside in fig. 1. They are tested to a pressure of 4 tons per square inch and are expected to contain air at the pressure of 350 atmospheres. They are so arranged in connection with the gun that air from any number of them may be admitted to the gun at once. The reservoirs and the piston valves which regulate the discharge of the air are of Whitworth compressed




steel. The reservoirs are charged from the air-compressor through pipes passing through the central pivot of the lower turret. The movement of the carriage upon the turret is regulated by hydraulic cylinders also, and it is claimed that one man can regulate the carriage, load and fire the gun. The air-compressor built for use in connection with this gun has four cylinders.

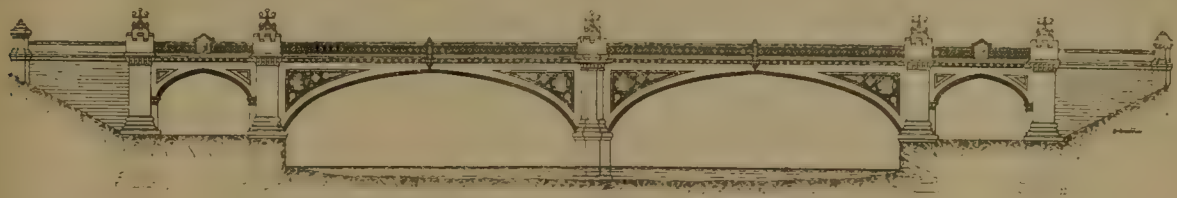
Fig. 2 shows the projectile in section. In order to prevent premature discharge, the explosive is made in small tubes or balls which are enclosed in paper saturated in paraffin. They are then placed in the cavity of the shell and separated by layers of paper. In order to secure the greatest possible penetration of the shell before explosion a spring is inserted, as shown, above the tube containing the exploder.

It is understood that an extensive series of experiments is to be undertaken with this gun in England and probably in France also.

## AN ENGLISH ROAD BRIDGE.

(Condensed from *Industries*.)

THE accompanying illustrations show a bridge just completed, which carries the Great Western Road—an important street—over the River Kelvin, in Glasgow, Scotland. The bridge was designed by Messrs. Bell & Miller, Engineers, and its total cost, including land bought and a temporary structure used while work was going on, has been about $200,000. Fig. 1 is a general elevation of the bridge; fig. 2 a transverse section through one of the large arches; fig. 3 an elevation of a pier; fig. 4 is one of the bracing frames, showing the circular openings for the water pipes.



GREAT WESTERN ROAD BRIDGE, GLASGOW, SCOTLAND.

The bridge is 60 ft. wide, and consists of two large spans of 91 ft. each, and two small spans, one of 34 ft. on the east side and one of 20 ft. on the west side. There are three piers, which occupy the site of the piers of the old bridge, and they, as well as the abutments and wing walls, are faced with granite. The piers are surmounted with handsome capitals, supporting lamps. The bridge throughout is in the Gothic style, the arches being formed by cast-iron segments, surmounted by a handsome parapet of the same material. The footpaths are 12 ft. in breadth and the roadway 36 ft. The pipes conveying the water supply from Loch Katrine to Glasgow are carried across the bridge beneath the roadway.

The foundations of the structure presented no features of difficulty, both piers and abutments resting on the rock, which here comes to the surface. The Kelvin is, moreover, very shallow at the site of the bridge, and light temporary cofferdams of iron plates readily excluded the water and allowed the piers to be founded in the dry. In the case of the west abutment, the presence of coal workings beneath rendered special precautions advisable, and the cast-iron columns penetrating to the floor of the old workings, which had been put in when the old bridge was widened, were accordingly retained and utilized. These columns are connected at the top by a substantial cast-iron platform, on which the masonry of the abutment has been built. Wrought-iron frames have also, as an additional security, been bedded in the masonry of this abutment. The wing walls have footings 12 in. deep with 6 in. scarcements. The central pier rests on rock, and has a total width of 75 ft. at the lower portion and of 71 ft. from face to face of the polished granite columns.

Fig. 2.

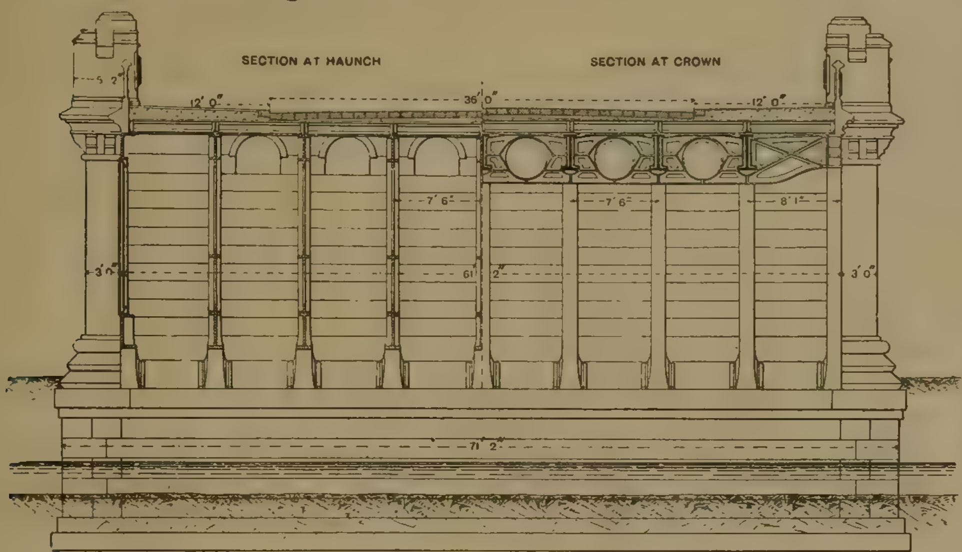
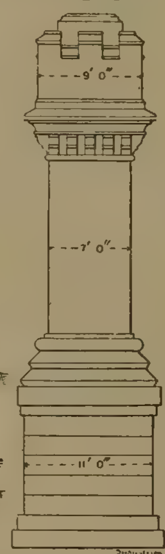



Fig. 3.



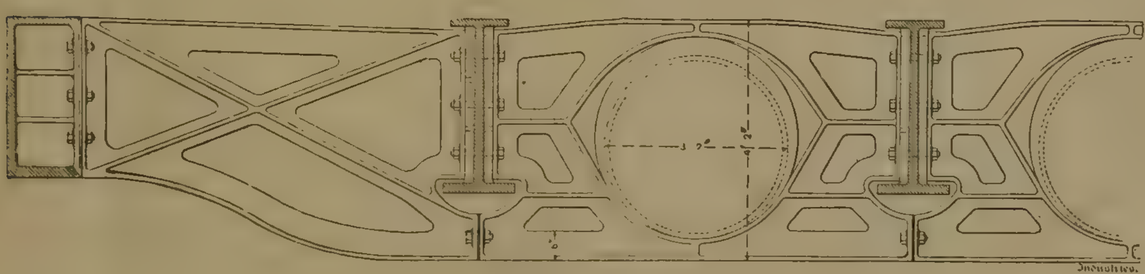



Fig. 4.

The arches of the bridge are formed by a series of seven main cast-iron girders and two cast-iron face girders, each girder being in five segments bolted together—that at the crown having the spandrel cast on. The face girders are of a handsome and ornamental character, as will be noted from the accompanying illustrations. Each of the girders on the west pier rests upon a cast-iron framed bed-plate, fitted and bolted with 1-in. bolts to the wrought-iron girder frames, which are built into the masonry of the piers,

wrought-iron keys being fitted between the bed-plate snugs and the soles of the girders to prevent any lateral movement. The spandrels of the main girders are also of cast iron, and are in three sections bolted together, the upper flanges of the spandrels carrying the platform road beams, and being connected with the lower flanges by vertical and diagonal bracing. The cast-iron spandrels of the face girders have panels of ornamental castings and shields, surrounded by continuous moulding, the shields having armorial bearings in relief. The platform road beams are of best mild Siemens-Martin steel, and are secured by bolts to the upper flanges of the spandrels. Brick jack arches span the spacing between the road beams. The haunches of the jack arching are filled in with fine concrete to the level of the crown of the arch—viz., to the same level as the top of the platform beams.

The span of the main girders is 91 ft., the rise 18 ft. 3 in., the section being of an **I** form, 3 ft. deep throughout; the upper and lower flanges being each 12 in. and 15 in. wide and 1½ in. and 2 in. thick respectively, and the web 1½ in. thick at top and 1¾ in. at bottom. The span of the face girders is 91 ft., the rise 18 ft. 6 in., the section 2 ft. 9 in. deep throughout; the upper and lower flanges being 1½ in. and 2 in. respectively, and the web at top 1½ in. thick and at bottom 1¾ in., the lower outer edge being ornamented with a raised moulding. The joint flanges of the main and face girder segments are 2¼ in. thick, each joint being secured by eight bolts, 1¾ in. diameter. The main girder spandrels have upper and lower flanges 1¼ in. to 1½ in. thick respectively, the web and vertical rib being 1¼ in. thick, the joining flanges being 1½ in. thick, and the bolts for connecting the same 1½ in. diameter. The lower flanges of the spandrels are made to suit the curve of the upper flanges of the girders, and are fitted to them by means of strips and 1¼-in. square-necked bolts.

The span of the main girders of the side spans are 34 ft. and 20 ft. respectively, with a similar rise of 8 ft. 9 in., and section of **I** form, 1 ft. 9 in. deep throughout; the upper and lower flanges being each 12 in. wide for both spans, and 1⅛ in. and 1½ in. thick respectively, with webs 1 in. thick at top and 1¼ in. thick at bottom. The face girders of the side spans are 34 ft. and 20 ft. respectively, with 7 ft. 9 in. rise, and are thus ] in section, 2 ft. 9 in. deep throughout; the upper and lower flanges are 12 in. and 15 in. wide and 1⅛ and 1½ in. thick respectively, the lower outer edge having a raised molding.

As regards the materials used in the structure, the cement employed is the best Portland, finely ground, and with a minimum tensile strength of not less than 350 lbs. per square inch after seven days' immersion in water, the briquettes having been previously allowed to set for not more than 16 hours after gauging. The weight per striked bushel is specified at 112 lbs., with a residue of not more than 15 per cent. after passing through a sieve of 2,500 holes per square inch. The concrete is composed of 1 part of Portland cement by measure, 2 parts of clean sharp river sand, and 3 parts of gravel or 2-in. broken whinstone; a special finer concrete in the lock arches being composed of 1 part of Portland cement to 3 parts of crushed granite sand. The mortar employed is mixed in the proportion of 1 part of Portland cement to 2 parts of clean sharp river sand. The outside elevations from cornice level of the piers, abutments, parapets, newels, and lamp towers are faced with gray granite fine-axed over the face, and presenting a handsome appearance. The red granite panels and columns are polished, and greatly enhance the appearance. The footings of the center and two side piers are 18 in. and 15 in. deep, and are built of stones from 3 ft. to 4 ft. long and from 2 ft. to 3 ft. broad, squared and pick-dressed. The abutment footings consist of one course of cement concrete 2 ft. thick, and one course of stones 12 in. deep, from 3 ft. to 4 ft. long by 2 ft. to 3 ft. broad, squared and pick-dressed. The ashlar is laid in cement mortar, no joint exceeding $\frac{1}{16}$ in. being permitted. All the coping is secured by small granite cubes set in cement. The facing of the wing walls above ground is chisel-dressed in face and rock-dressed up to level of parapet.

The platform of the bridge is covered with a layer ¾ in. thick of best British bitumen manufactured from pure coal tar pitch. The carriage-way is of granite, the stones having a uniform depth of 6½ in. by 4 in. thick, their length being not less than 9 in. and not more than 14 in. The stones, which are required to be properly squared and dressed, are bedded on mortar and run in with hot pitch, no sand by itself being permitted to be used for bedding them. The gutters and curb are of granite, the stones being 12 in. broad by 7 in., and rough-axed on the surface, lengths of 3 ft. to 4½ ft. being specified. The pavement is composed of best patent granolithic laid upon concrete.

The cast iron, which forms the main item in the superstructure, is specified to stand without fracture a load exceeding 29 cwt. at the center of a bar 1 in. thick, 2 in. deep, and placed upon supports 3 ft. apart. The bars are specified to be cast 42 in. long, and three such are required from each melting. The usual requirements as to perfect soundness, evenness, surface, uniform thickness, and freedom from flaws, such as slag, air-holes, blisters, wants, lumps, inequalities, and similar imperfections, are duly exacted.

The steelwork in the flooring, etc., is required to stand a tensile load of 26 tons per square inch without fracture, every plate or bar being stamped with the maker's brand, and all surfaces being smooth, free from blisters, cracks, or flaws of any kind. The rivets are of best mild Siemens steel, capable of sustaining a tensile stress of not less than 26 tons per square inch, one rivet in every 200 being tested.

The lamp standards are bronzed and tastefully picked out with gold, while the dog-tooth molding round the arches, the outer molding of the panels on the spandrels, the bosses projecting from cavetti, and the armorial shields and panels are also gilded with gold leaf.

## NOTES ON COMBUSTION.

By C. Chomienne, Engineer.

(*Continued from page* 447.)

### HEATING SURFACE.

The heating surface of a boiler is composed of two parts:

1. The direct heating surface, which transmits to the water the heat developed by the fire-box, either by radiation or by contact.

2. The indirect surface, which transmits the heat only by contact.

It is then evident that 1 sq. m. of direct heating surface will produce more steam than 1 sq. m. of indirect surface; the more so since the gases in contact with the indirect heating surface have already lost a part of the heat which they contained in leaving the fire-box, and that the transmission through the walls of the tubes is in proportion to the difference of temperature between the gas and the wall or surface.

Many experiments, confirmed by practice, show that the quantity of heat transmitted by a unit of surface decreases rapidly as the distance from the fire-box increases, and consequently the increase of indirect surface beyond a certain limit is useless and only serves to make the boiler more complicated.

On the other hand, we can decrease too much this indirect surface, because when the products of combustion escape at too high a temperature, the formation of steam will rapidly diminish. This temperature in the case of an ordinary chimney 25 to 30 m. in height should never pass 200° C.

Regnault has made up a table of the specific heats of certain gases contained in the products of combustion, and he has shown that the specific heat of these gases differs very little from that of air, which is 0.240. If, then, we admit that we burn 20 kgs. of air and 1 kg. of coal, and that the gases escape from the chimney at a temperature of 300° C. instead of 200° C., the loss in calorics will be

$$20 \times 0.24 \times 100 = 480 \textit{ calorics.}$$

If the heating power of this coal is 7,000 calorics, the loss will be represented by

| Coal burned per square meter of grate, kilograms. | Heating surface per square meter of grate, in square meters. — Direct. | Heating surface — Indirect. | Heating surface — Total. | Surface per kilogram of coal. | Quantities of Heat. Transmitted by 1 square meter of grate to the heating surfaces. — Direct. | Transmitted — Indirect. | Transmitted — Total. | Utilized. — Per square meter of grate. | Utilized — Per square meter of surface. | Utilized — Per kilogram of fuel. | Useful result, per cent. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EXTERNAL FIRE-BOX—COOLING OF GASES TO 250° C. | | | | | | | | | | | |
| 50 | 3.00 | 25.39 | 28.39 | 0.568 | 108,135 | 149,765 | 257,900 | 245,900 | 8,661 | 4,918 | 61.4 |
| 75 | 3 00 | 31.71 | 34.71 | 0.453 | 141,625 | 245,225 | 386,850 | 368,850 | 10,626 | 4,918 | 61.4 |
| 100 | 3.00 | 37.69 | 40.69 | 0.407 | 169,392 | 346,408 | 515,800 | 491,800 | 12,086 | 4,918 | 61.4 |
| INTERIOR FURNACE, CORNISH BOILER—COOLING OF GASES TO 250° C. | | | | | | | | | | | |
| 50 | 1.50 | 31.33 | 32.83 | 0.656 | 93,846 | 200,604 | 294,450 | 282,450 | 8,598 | 5,649 | 70.6 |
| 75 | 1.50 | 38.50 | 40.00 | 0 433 | 124,183 | 317,492 | 441,675 | 423,675 | 10,592 | 5,649 | 70.6 |
| 100 | 1.50 | 45.22 | 46.72 | 0.467 | 150,405 | 438,495 | 588,900 | 564,900 | 12,091 | 5,649 | 70.6 |
| INTERIOR FURNACE, LOCOMOTIVE TYPE OF BOILER. COOLING OF GASES TO 250° C. | | | | | | | | | | | |
| 50 | 5.00 | 30.24 | 35.24 | 0.704 | 140,878 | 166,122 | 307.000 | 283,000 | 8,030 | 5,660 | 70.8 |
| 75 | 5.00 | 37.68 | 42.68 | 0.569 | 185,631 | 274,869 | 460,500 | 424,500 | 9,946 | 5,660 | 70.8 |
| 100 | 5.00 | 44.25 | 49 25 | 0.493 | 222,820 | 391,180 | 614,000 | 566,000 | 11,331 | 5,660 | 70.8 |
| [illegible] | 5.00 | 73.30 | 78.30 | 0.391 | 329,710 | 898,290 | 1,228,000 | 1,228,000 | 14,470 | 5,660 | 70.8 |
| 400 | 5.00 | 114.54 | 119.54 | 0.299 | 479,175 | 1,976,875 | 2,456,000 | 2,456,000 | 18,889 | 5,660 | 70.8 |

$$\frac{480}{7000} \times 100 = 6.85 \text{ per cent.}$$

We may remark that this loss is greater as the quantity of air used is greater; and as the figure of 20 kgs. can be considered almost a minimum, it follows that this loss will be almost always greater than the figure given above.

The ratio between the direct and indirect heating surfaces varies according to the type of boiler and according to the strength of draft. The more the latter is increased the more the indirect heating surface may be increased.

The accompanying table, given by M. Ser, shows the proportions generally adopted in the three types of boilers most commonly used. The results of this table are applicable to fire-boxes burning coal, the radiating power varying with different kinds of fuel. The importance of the direct heating surface decreases when the fuel has less radiating power. The small table below permits us to take account of its effect:

| Fuel. | Calorific Power. | Radiated Heat. | Relative Radiating Power. Coke=1. |
|---|---|---|---|
| | *Calories.* | | |
| Coke of good quality...... ... | 7,000 | 60 per cent. | 1.000 |
| Anthracite or dry coal... .... | 7,500 | 55 " | 0.916 |
| Soft coal, with long flame..... | 6,600 | 50 " | 0.833 |
| Lignite, very dry............ | 5,600 | 40 " | 0.667 |
| Peat, dried at 100° C.......... | 3,800 | 30 " | 0.500 |
| Wood, dried at 140° C........ | 3,650 | 28 " | 0 467 |
| Wood with 25 per ct. of water. | 2,900 | 25 " | 0.417 |

In steam generators placed over heating furnaces in metallurgic establishments, the direct radiation of the furnace does not exist and the average production of steam to the square meter of heating surface is considerably diminished. In practice it is usual to give to such generators a heating surface almost equal to that which they would have if the whole quantity of fuel employed in the furnace was burned in them directly.

If we admit a duty of 65 per cent. for the boiler with ordinary fire-box, this same boiler placed on a heating furnace would not give more than three-fifths of the result obtained in the first case, so that the coefficient would not be more than

$$0.65 \times \tfrac{3}{5} = 0.39$$

—that is, about 40 per cent. of the theoretical efficiency.

PRODUCTION OF STEAM PER SQUARE METER PER HOUR.

In boilers fired externally the average production of steam per square meter of heating surface per hour should be from 10 to 15 kg. If below 10 kg. there is too great an extension of heating surface; if above 15 kg. there is a loss of heat by the gases—that is, through the chimney.

As to tubular boilers, without artificial draft, the production may vary from 15 to 20 kg., 18 kg. being a very fair normal production.

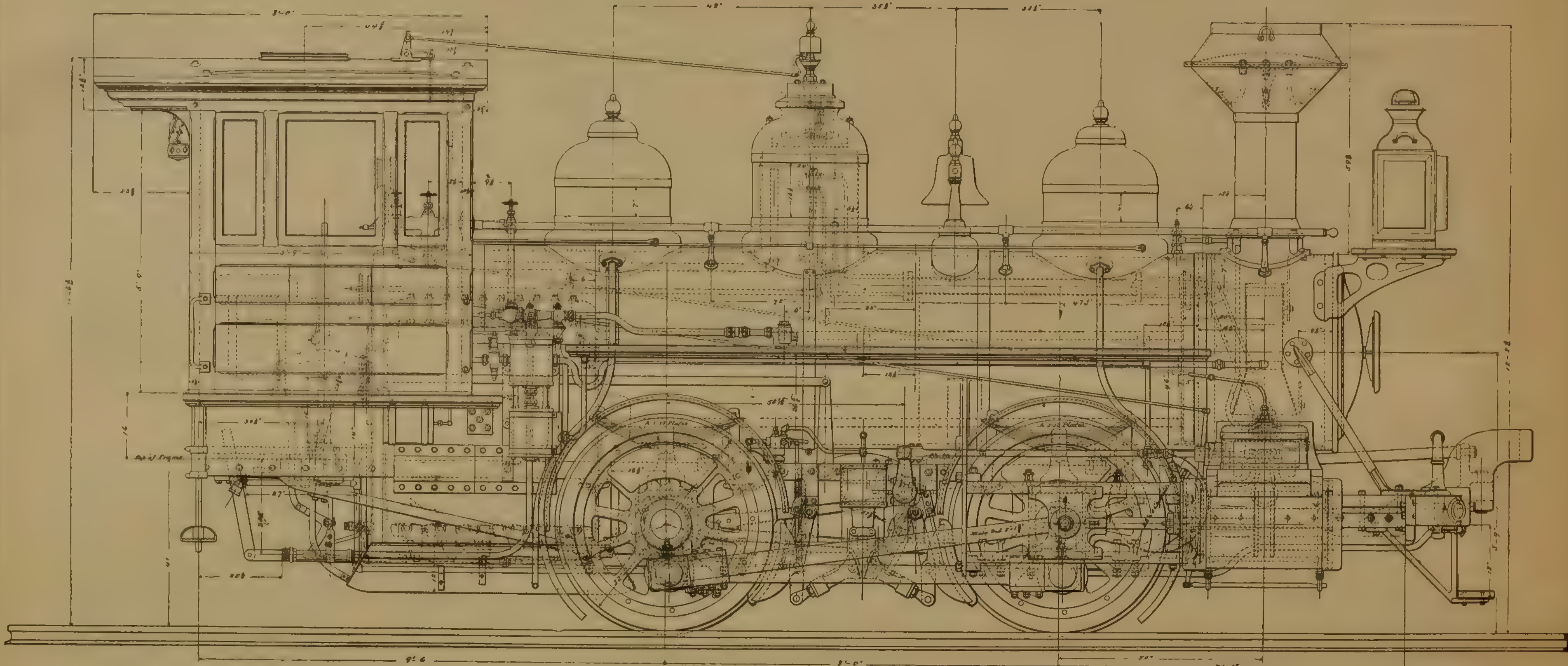
These figures correspond very nearly to 75 kg. of coal burned per hour and per square meter of grate; that is, with fine coal, or what is called in trade "run of mine." With certain fuels, like anthracite coal, the consumption can be reduced to 50 kgs.

According to M. Lencauchez, the difference of production per square meter of heating surface—13 kg. on an average for externally fired boilers and 18 kg. for tubular boilers—holds good for tubes of from 0.065 to 0.115 m. in diameter, these tubes being of metal, and of small section, which accelerates the draft considerably, and prevents gases from making their exit from the boiler without losing their heat in contact with the surfaces, the small size preventing cooling and actively mixing up the gas.

In externally fired boilers, the passages are necessarily of considerable section, and the heated gases have a tendency to rise toward the top. This, being of brick, does not cool them as quickly as a metallic surface, from which there results a less perfect absorption of heat and mixture of gases. The brick surfaces, it is true, radiate some heat upon the boiler, but the heat radiated represents hardly one-half of that absorbed, the rest being scattered through the masonry wall and lost by exterior cooling.

To this class of boilers the principal objection consists of the importance of the losses of heat resulting from the mass of masonry. The losses are decreased in cases where the heating surface is large and the masonry surface is made as small as possible. The thickness of the walls, moreover, and good joints help very much to diminish the leakage or entry of air, and in consequence to improve the result obtained.

Semi-tubular boilers generally give a very good result, especially if they are not driven too hard, and for that reason they should have a large heating surface. In order that the draft should not be interrupted too much by the reduction in section due to the passage into the tubes, the total section of the tubes should be at least 0.30 sq.m. per square meter of grate surface. These boilers give still



FOUR-WHEELED SWITCHING LOCOMOTIVE, BOSTON & ALBANY RAILROAD.

A. B. UNDERHILL, SUPERINTENDENT OF MOTIVE POWER.

better results when the passage of the gases into the tubes is not completed on the second course, but on the third, for then we do not have to fear the extinction of the flame or the separation of the combustible gases, which are produced when these gases enter the tubes at a very high temperature.

Masonry furnaces permit the use of coal of a poor quality, which could not be properly burned in a tubular boiler. In some cases externally fired boilers are found producing results almost as good as tubular boilers, and they certainly have the merit of simplicity in construction and comparative cheapness.

The tubular boiler with interior fire-box occupies much less space than an externally fired boiler, and for that reason alone it is often preferred. In every boiler of this class the combustion chamber should have sufficient size, since if it is too small the gases reach the tubes before they are completely burned, and the combustion is there stopped. The tubular boiler also permits the use of higher pressures than can be obtained with a plain cylinder boiler, because to resist such pressures the plates must be made so thick as to obstruct the passage of the heat.

TUBULOUS BOILERS.

In cases which are often presented, a boiler carrying a great volume of water is not the best for high production of steam. Thus, if in a cylinder boiler we increase the production of steam from 20 to 40 per cent., the efficient result is decreased from 5 to 10 per cent., while in tubular boilers the production of steam is increased with difficulty, and the efficiency at once falls from 10 to 20 per cent. As soon as we attempt to make one of these boilers produce more than 15 kgs. of steam per square meter of heating surface, the efficiency diminishes. Their only advantage is to permit the use of pressures as high as 200 lbs. without danger. The collapse of a tube will extinguish the fire at once. The problem of the production of steam at a very high pressure cannot, in fact, be solved in a practical way by the use of externally fired boilers, nor of boilers with interior fire-box, nor even with semi-tubular boilers, because their large dimensions require very thick plates in order to resist the force of the steam. These heavy plates cause a great increase of weight, and at the same time make the transmission of heat through them more difficult and the boiler less economical, without considering the fact that they increase the strains resulting from the inequality of temperature of different parts of the boiler, which tends to crack the plates and increase the danger of explosion. Finally the consequence of these accidents would be especially disastrous, since the destruction caused by a boiler which explodes is proportional to the quantity of water which it contains, and increases with its temperature.

In tubulous boilers, as they are sometimes called, or boilers composed of small elements, the tubes have a diameter varying from 0.07 m. to 0.12 m.; they can carry, in spite of their small thickness, very high pressures, and thus secure better transmission of heat through the metal; finally—and this is an essential point—the volume of water enclosed is very much less for an equal surface, so that the dangers of explosions are very much reduced.

The security which such boilers offer results not only from their small capacity, but from the subdivision of the water and the steam among a large number of tubes which communicate with each other only by narrow passages. In this way, if there is an explosion, the difficulty of communication between the different parts of the boiler prevents that instantaneous explosion, which is so terrible in the case of a large boiler. The whole thing is simply an escape of water and steam; one might almost say a simple leakage, of greater or less size, the steam escaping by the chimney, and the water into the fire-box.

Statistics have shown that boilers of this kind are, it is true, exposed to more frequent collapse of tubes, but this does not cause considerable damage. They compose a class of explosions of a special nature, the effects of which may be dangerous to the persons employed close to the boiler, but quite harmless for those at a short distance away only, or in other parts of the shop.

The doors giving access to the tubes should be kept carefully closed, and also the fire-box doors, as in case of the giving way of a tube, there will be much less danger.

In some of these boilers, in order to make their work more regular, the proportions of the reservoirs of water or of the steam drums are increased; but when this is done the danger of an explosion is also increased.

From the point of view of the steaming capacity per unit of heating surface, we should not require a tubulous boiler to produce more steam in proportion than is required from others.

The tendency to use these boilers composed of small elements and called "safety boilers," such as the Belleville, the Roser, the Terne & De Harbe, the Montupet, the Collet, the Babcock & Wilcox, the Ward, the Cowles, etc., is at present very marked. It is due probably to the increasing use of compound and triple-expansion engines, and also to the special conditions required in the application of electricity in cities, where space is limited, and where an explosion would have severe consequences.

I may say, however, in a general way, that they ought not to be used where the pressure required is not over 90 lbs., or where there are great variations in the supply of steam required, as the maintenance of the pressure and of the water level becomes very difficult in such cases. We are then obliged to have recourse to automatic apparatus to regulate the feed, and also to apparatus of some kind to regulate the pressure by acting upon the draft, as is very frequently done with Belleville boilers.

It may also be said that these boilers require very good water on account of the difficulty of cleaning them.

(TO BE CONTINUED.)

## A FOUR-WHEEL SWITCHING LOCOMOTIVE.

THE accompanying engraving is from a working drawing of a four-wheeled switching locomotive of very neat design, built in the shops of the Boston & Albany Railroad for use on that road, under the supervision of Mr. A. B. Underhill, Superintendent of Motive Power.

The general design of the engine is well shown in the drawings, and presents no special features. The entire weight is carried on the four driving-wheels; as the engine weighs 66,000 lbs. ready for service, the average load per wheel is 16,500 lbs. The wheels are 52 in. in diameter, and are 8 ft. apart between centers. From the center of main driver to rear end of frame is 9 ft. 6 in.; from center of forward driver to front end of frame, 7 ft. 1 in., making the total length of the frames 24 ft. 7 in.

The boiler is 46 in. diameter of barrel; the shell is of Otis steel, ⅜ in. thick. There are 121 tubes, 2 in. outside diameter and 11 ft. 11⅝ in. long. The fire-box is of steel, and has a rocking grate. The boiler is built for a working pressure of 130 lbs. The center of the boiler is 5 ft. 9 in. above the top of the rail; the total height, from top of rail to top of smoke-stack, is 12 ft. 8¾ in. The boiler is of the straight-top pattern, and the steam-dome is near the center of its length.

The cylinders are 16 in. in diameter and 24 in. stroke. The cross-head and guides are of the pattern shown in the drawing. The main rod is 8 ft. 1 in. long between centers. The valve gear is of the ordinary shifting link type.

The engine is provided with air-pumps and driver-brakes. There are two sand-boxes, as needed in an engine of this class. The front draw-head is a heavy casting, bolted to the bumper-beam and braced to the cylinder saddle by a heavy tie-rod.

The engine has no tanks, the water and fuel being carried on a separate tender.

## THE UNITED STATES NAVY.

SOME remarkable results have been recently secured by the Ordnance Bureau with the 4-in. rapid-fire gun provided with the Dashiell breech mechanism. At a trial at the proving-ground at Indian Head, on the Potomac, the gun was tested with the service charge of brown powder,

firing in salvos of five rounds. The first five were fired in 26 seconds, the second in 22 seconds, and the third in 17 seconds.

The 10-in. guns for the coast-defense ship *Monterey* have been tested, with very satisfactory results.

It is understood that the Navy Department has decided to make the 6-pdr. Hotchkiss gun the leading gun in secondary batteries. The reason for this is that, while the 6-pdr. throws a heavier projectile and has a greater range, it can be handled and worked almost as easily as the 3-pdr. gun.

ELECTRIC SIGNAL APPARATUS.

A new electric apparatus for directing the movements of a ship from the conning-tower is now under consideration by the Navy Department. It was submitted by Lieutenant Bradley A. Fiske, the inventor of the range-finder, and its object is to supply perfect automatic means of communication; it has so far succeeded as to bring battery, helm, and engine much more completely under the control of a single person than has heretofore been accomplished.

The new system includes numerous arrangements of apparatus. There are placed in the fighting-tower two arcs of conducting material, over which moves two pivoted arms. The arcs are graduated on each side of their central points to indicate revolutions of the propeller of the vessel. The arcs and arms are connected in series with two indicating instruments, one arc and one indicating instrument being located either on the bridge or in the fighting tower, the other one in the engine-room.

In connection with the needle of the instrument of the engine-room indicator are arranged two local circuits, each containing a bell or other suitable alarm. These circuits are respectively closed as the needle moves to its stops in one direction or the other.

If, for instance, it is desired to send a signal to the engineer to "go ahead," the arm of the arc in the fighting tower is moved to the right, and by this means the resistance in the circuit is diminished, causing a deflection of the needles of the two indicators in the same direction. The engineer then not only sees the needle of his indicator move, but also hears a bell sound. As this bell may be of different tone from the one included in the other local circuit, he has both visible and audible notice of the order.

Meanwhile, the person sending the order notes by the deflection of his indicating instrument that it has been transmitted. Numbers in the arc denote the order to be obeyed.

The steering of the ship is effected by a similar arrangement working on a steam-steering engine controlling the helm.

THE VICTORIA TORPEDO.

This torpedo has attracted much attention, and the accompanying illustration and description are taken from the latest report of the Naval Intelligence Office. It is understood that it is soon to have a very thorough test.

The coast-defense type of this torpedo is similar in form to the auto-mobile torpedoes now in general use, and is divided up into six compartments, as shown in fig. 1. The forward compartment contains the explosive charge, which is compactly stowed in the lower part, the upper part being divided into five compartments, four vacant and intended to contain water, the fifth, *D*, containing Holmes' light composition. Attached to the forward bulkhead of the air-chamber is a diaphragm, *B*, so connected to the piston-rod of a piston-valve, *C*, moving vertically in the cylinder *A* as to cause the piston to gradually descend in its cylinder as the air pressure decreases in the compressed-air chamber, allowing water to flow in through the thus opened top of the cylinder *A* to successively fill each of the four compartments mentioned above, in this manner adding weight forward to compensate for the loss of the expended air.

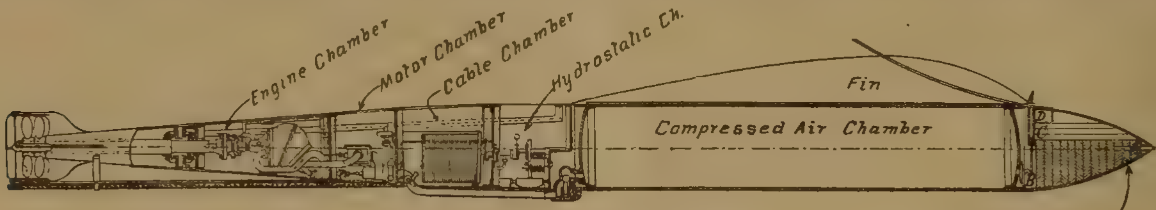



FIG 1

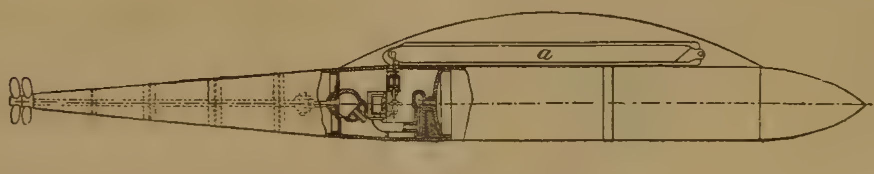



FIG 2

THE "VICTORIA" TORPEDO.

The compressed-air chamber is connected with the engine by means of an admission-pipe as shown, this pipe being fitted with a valve operated by one of three motors in the motor chamber. To the rear of the compressed-air chamber is that for the hydrostatic valve, which, with its pendulum and servo-motor, actuates a horizontal rudder to keep the torpedo at a set depth when running. In the rear of this is the electrical cable chamber. The torpedo is controlled from the firing station on shore through the medium of a flexible gutta-percha cable of a specific gravity not varying much from that of sea-water, of which about 3,600 ft. are coiled in this chamber, the remainder being coiled up at the firing station ready for unreeling. This cable contains three sets of separately insulated copper wires, by means of which the power necessary for controlling, steering, raising to the surface and firing the torpedo is transmitted from suitable electrical batteries at the firing station to three magneto-electric motors placed in the next chamber to the rear. Of these motors the forward one is used to actuate the spindle of the compressed-air valve and regulate the admission of compressed air to the spherical air engine in the after chamber. The second motor has two functions. With a direct current it acts along a rod connecting it to a fuse in the nose of the torpedo to fire the charge (unless caught in a net or boom protection the fuse is intended to act by percussion), but with a reverse current it will serve to actuate, by means of a rod and gearing, a horizontal rudder to bring the torpedo to the surface of the water. The rear motor serves to actuate the vertical steering rudders.

When the torpedo is first discharged the cable will be paid out from shore, that reeled up in the torpedo being held by a grip, which at any time, by means of a cord and spring, can be released by opening the air-valve to its full limit, thus permitting cable to be paid out from the torpedo. The fin is shown in the figure, and this torpedo can be used with or without a float. The two propellers are right and left-handed, similar to those of the White-

head. Mr. Murphy's intention is to so arrange this torpedo that it can also be launched from fixed under-water positions in harbor, a mile or more from shore. For this purpose the torpedo, with an accompanying buoy, is held by four locked arms in a cage moored at the bottom. The buoy contains a coil of electric cable, and the cage is connected with the firing station on shore by a cable containing five strands of copper wire, three of them for the operations described above; a fourth to cause the setting free of the torpedo and buoy, and the fifth, which is connected with electric cells, to cause the ringing of a bell at the firing station in case of accident to the torpedo or its cable. To operate the torpedo from such a position, it is released from its cage and then started off, pulling cable out of its buoy instead of from the shore, as in the case given above.

Mr. Murphy has also designed the naval torpedo shown in fig. 2, in which, instead of the hydrostatic valve used in the shore torpedo, he will use a dorsal fin, in which will be secured a float, *a*, which, through a dash-pot and servo-motor, will operate a side fin to keep the torpedo about 2 ft. under water.

## A NEW SLOPE STAKE SETTER AND SLOPE INDICATOR.

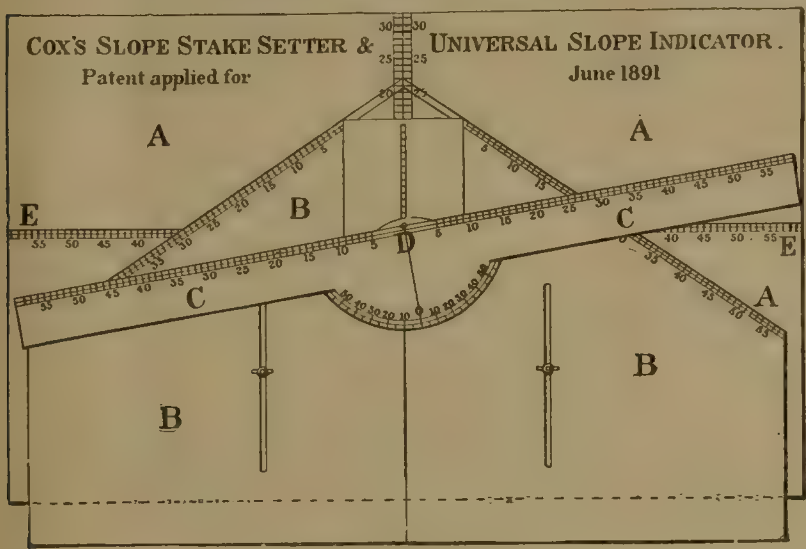
The accompanying illustration shows a new contrivance invented by Mr. William Cox, and made by the Keuffel & Esser Company, of New York, which must be of great use to engineers. For the engravings and description we are indebted to *The Compass*.

This device serves two special purposes:

1. By its means the exact point of intersection of the slope of an embankment or cutting with the natural surface of the ground, and consequently the position of the slope stakes, is immediately and accurately ascertained, and that without any calculations whatever.

2. The instrument gives instantly and also without any calculation all the various dimensions of embankments or cuttings, with varying ground surfaces and side slope ratios, from which the area of the cross-section may be calculated in the simplest manner possible and in the shortest time.

The indicator consists of three flat pieces of wood, metal, Bristol board, or other material—namely: *A A* the foundation plate with a central horizontal line and a central vertical line, both graduated to a convenient scale of feet. The point of intersection of these two lines represents the center line along the natural surface of the ground, while the center height is measured upward from the same on the vertical line. *B B* a vertical sliding-piece representing the cross-section of an embankment or cutting. This piece is interchangeable, so that it may suit different slope ratios and widths of road-bed. The slopes are graduated to the same scale of feet, as is also a vertical line drawn downward on each side of the road-bed, giving the height of each of its sides above the ground surface. *C C* a straight scale revolving upon the point *D* and representing the varying degrees of slope of the natural surface of the ground. This straight scale, which is graduated to feet right and left from its center, has fixed to its lower edge a semi-circular protractor, by means of which it may be set to any angle of slope.




"Copyright, 1891, by William Cox."

Fig. 1.

These three pieces are kept in their respective positions by means of three small flat-headed screws with thumb-nuts, the middle one *D* acting as a pivot upon which the straight scale *C C* can be turned round. In the sliding section *B B* are three slots, through which the screws pass, so that a vertical movement up or down can be given to this piece.

To use the indicator, the sliding section is raised to the required center height, and the straight scale turned to the angle of slope of the surface of the ground; the point of intersection of each of the side slopes with the surface of the ground is then at once seen, and their respective distances from the center line easily read off, thus fixing without estimation or trial the exact position of the slope stakes. The length of each of the side slopes can also be at once ascertained if required. Thus in fig. 2 the road-bed *a b* is assumed to be 18 ft. wide, and the height of the center line above the surface of the ground, or *d e*, is taken as being 12 ft., while the side slopes *A a* and *B b* are $1\frac{1}{2}$ to 1, and the angle of the surface of the ground with the horizon is 10°. After setting the sliding-piece *B B* to 12 ft. and turning the protractor to 10°, we at once see that *A e* measures 37.2 ft. and *B e* = 21.6 ft. These distances then measured out from *e* are the positions of the slope stakes.

When the surface of the ground presents a different slope on each side of the center line, the straight scale must be set first to one slope and the distance read off, and then to the other slope and its corresponding distance noted.

We have said that this instrument serves also to ascertain in a very simple manner the cross-sectional area of an embankment or cutting. This may be done very quickly in the following way:

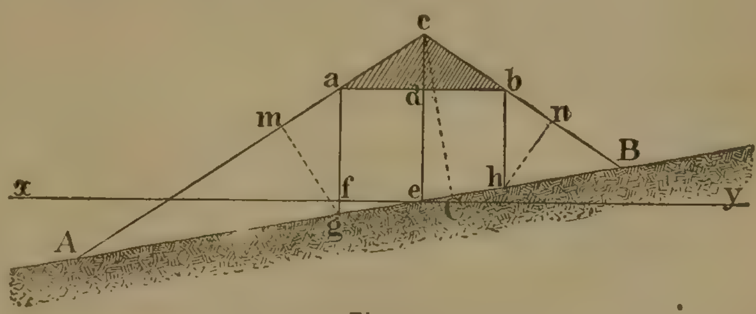



Fig. 2.

The side slopes of the sliding section *B B* are prolonged upward until they meet, as shown at *c* in fig. 2, thus forming with the ground surface line a triangle *A B c*. A graduated square, which slides along the straight scale (kept in position by a slot, through which passes the pivot *D*) enables the length of the perpendicular *C c* to be

immediately noted. This distance, as shown in fig. 2, is found to measure 17.8 ft. We then proceed as follows:

| | | |
|---|---|---|
| $A\ e$, already ascertained | = | 37.2 |
| $B\ e$ " " | = | 21.6 |
| whence $A\ B$ - | = | 58.8 ft. |
| Half of $C\ c\ \left(\frac{17.8}{2}\right)$ - - | = | 8.9 " |
| Their product | = | 523.32 sq. ft. |

which is consequently the area of the triangle $A\ B\ c$. From this we now deduct the area of the small triangle $a\ b\ c$, which is a constant for all road-beds of the same width with the same side slopes, and is obtained by the formula $a\ b \times \frac{a\ b}{4r}$, where $r$ is the ratio of the side slopes. In the present example this constant is $18 \times \frac{18}{4 \times 1\frac{1}{2}} = 54$ sq. ft., so that we have

| | | |
|---|---|---|
| Area of triangle $A\ B\ c$ | = | 523.32 sq. ft. |
| Less " " " $a\ b\ c$ | = | 54.00 " |
| Leaves | | 469.32 " |

as the area of the cross-section $A\ a\ b\ B$.

A list of constants, $K$, is furnished for different widths of road-beds and various slope ratios, to be used with the formula applying to the indicator—namely:

$$\text{Cross-sectional area } A\ a\ b\ B = (A\ B \times \tfrac{1}{2}\ C\ c) - K,$$

by means of which any area may be obtained in the shortest space of time possible.

This instrument will be found specially useful for the purpose of making out preliminary estimates, from the facility and accuracy with which the various dimensions and areas may be obtained.

This machine has been copyrighted and application made for a patent.

## THE GOVERNMENT TIMBER TESTS.

An interesting circular has been issued by Mr. B. E. Fernow, Chief of the Forestry Division of the Department of Agriculture, in relation to the tests of timber undertaken by the Department. The object of these is to determine the properties of different kinds of timber and of timber grown in different parts of the country by a large number of tests on material of known origin. The points to be determined are formulated as follows:

"What are the essential working properties of our various woods and by what circumstances are they influenced? What influence does seasoning of different degree have upon quality? How does age, rapidity of growth, time of felling, and after-treatment change quality in different timbers? In what relation does structure stand to quality? How far is weight a criterion of strength? What macroscopic or microscopic aids can be devised for determining quality from physical examination? What difference is there in wood of different parts of the tree? How far do climatic and soil conditions influence quality? In what respect does tapping for turpentine affect quality of pine timber?"

It is also proposed to test, as opportunity is afforded, the influence of continued service upon the strength of structural material, as for instance of members in bridge construction of known length of service. This series of tests will give more definite information for the use of inspectors of structures.

Besides these problems, many others will arise and be solved as the work progresses, and altogether a wealth of new knowledge regarding one of our most useful materials must result. It is proposed to publish results from time to time.

### ORGANIZATION AND METHODS.

There are four departments necessary to carry on the work as at present organized—namely:

I. The collecting department.

II. The department of mechanical tests.

III. The department of physical and microscopic examination of the test material.

IV. The department of compilation and final discussion of results.

The collection of the test material is done by experts (Dr. Charles Mohr, of Mobile, Ala., for Southern timbers). The trees of each species are taken from a number of localities of different soil and climatic conditions. From each site five trees of each species are cut up into logs and disks, each piece being carefully marked, so as to indicate exactly its position in the tree; four trees are chosen as representative of the average growth, the fifth or "check tree" the best developed specimen of the site.

Disks of a few young trees, as well as of limbwood, are also collected for biological study. The disk pieces are 8 in. in height and contain the heart and sapwood of the tree from the north to the south side of the periphery. From 50 to 70 disk pieces and from 10 to 15 logs are thus collected for each species and site.

A full account of the conditions of soil, climate, aspect, measurements, and determinable history of tree and forest growth in general accompanies the collection from each site.

The disks are sent, wrapped in heavy paper, to the Botanical Laboratory of the University of Michigan, at Ann Arbor (Mr. F. Roth, in charge), to be studied as to their physical properties, their macroscopic and microscopic structure, rate of growth, etc. Here are determined (*a*) the specific weight by a hygrometric method; (*b*) the amount of water and the rate of its loss by drying in relation to shrinkage; (*c*) the structural differences of the different pieces, especially as to the distribution of spring and summer wood, strong and weak cells, open vessels, medullary rays, etc.; (*d*) the rate of growth and other biological facts which may lead to the finding of relation between physical appearance, conditions of growth, and mechanical properties.

The material thus studied is preserved for further examinations and tests as may appear desirable, the history of each piece being fully known and recorded.

The logs are shipped to the St. Louis Test Laboratory in charge of Professor J. B. Johnson. They are stenciled off for sawing and each stick marked with dies, corresponding to sketch in the record, so as to be perfectly identified as to number of tree, and thereby its origin, and as to position in tree. After sawing to size, the test pieces are stacked to await the testing. One-half of every log will be tested green, the other half after thorough seasoning. A determination is made at the time of testing of the amount of water present in the test-piece, since this appears greatly to influence results.

From each tree there are cut two or three logs, from each log three or four sticks, two of standard size, the other one or two of larger size. Each standard stick is cut in two, and one end reserved for testing two years later after seasoning. The standard size for the sticks is 4 × 4 in. and 60 in. long for cross-breaking tests. There will, however, be made a special series of cross-breaking tests on a specially constructed beam-testing machine, gauged to the Watertown testing machine, in which the full log length is utilized with a cross-section of 6 × 12 up to 8 × 16 inches, in order to establish the comparative value of beam-tests to those on the small test-pieces. It is expected that, in the average, 50 tests will be made on each tree, besides 4 or 5 beam-tests, or 250 tests for each species and site. The methods adopted for the tests will be described more fully later.

All due caution will be exercised to perfect and insure the accuracy of methods and besides the records, which are made directly in ink into permanent books, avoiding mistakes in copying, a series of photographs, exhibiting the character of the rupture, will assist in the ultimate study of the material, which is also preserved.

The department of compilation and final discussion of results is as yet not organized.

### CONCLUSION.

Such work as this, if done as indicated, and well done, will never need to be done over again. The results will

become the standard, the world over. The strength and value of a given species or even stick will then no longer be a matter of opinion, but a question of established fact, and we will learn not only to apply our timbers to the use to which they are best adapted, but also what conditions produce required qualities, thus directing the consumer of present supplies and the forest grower of the future.

The American Association for the Advancement of Science in its Section of Mechanics and Engineering has created an Advisory Board, to assist in securing improved methods, and the co-operation of other authorities will be welcomed to make this a truly national work.

So far the work has been confined to Southern Pines and Oaks (which, thanks to the courtesy of the Louisville & Nashville Railroad Company, could be obtained free of transportation charges); the scant appropriations available, and other unfavorable conditions, making such limitation necessary.

The work will be extended and its progress pushed in proportion to appropriations made by Congress, which will depend upon the interest which the work may arouse among those to be benefited by it.

## THE INTERCONTINENTAL RAILROAD.

THE following report has been submitted to the State Department by Messrs. A. J. Cassatt, H. G. Davis, and R. C. Kerens, members of the Intercontinental Railway Commission on the part of the United States.

In a preceding report, submitted May 5, 1891, the Department was informed as to the line determined upon to be followed in making the survey and of the sailing of the three engineering parties selected to carry on the work. The consuls-general at Guayaquil and Guatemala City were instructed by the Department to extend every aid possible to the parties and to duly present them to the different Governments, by whom they were welcomed in the most cordial and hearty manner. The parties in Ecuador report that they were transported, with their baggage and equipments, from Guayaquil to Quito by that Government and at its own expense. The Government of Guatemala has also extended many favors and ordered some of their engineers to assist in making the survey through that Republic.

It is gratifying that the republics have welcomed and assisted so cordially the several surveying parties, as the enterprise is under mutual control and for the general benefit.

Some delay was occasioned, owing, in part, to inadequate communication and transportation, in the assembling of the delegates from the distant republics in Washington last winter; and delay has occurred in the payment of the money due from several of the republics, congressional action being necessary in each country.

The Congress of the United States appropriated $65,000 for the year ending June 30, 1891, and the same amount for the year ending June 30, 1892, making a total of $130,000. Of this amount there was on August 1, 1891, $56,910 remaining in the Treasury and available for use.

Chili has paid in $3,000 and Columbia $4,000, their quota to the common fund; so that on August 1, 1891, the Commission had about $64,000 for carrying on the work. We have information that some of the other republics are making arrangements to pay their proportion. The expenses are estimated at about $2,000 for each party per month and $1,000 for office and all other expenses, making about $7,000 for the total monthly outlay. It is therefore probable that it will be found expedient to ask of Congress a slightly larger appropriation for the next fiscal year. Your attention will be called to this matter in another communication previous to your transmitting to Congress your usual estimates.

The reports received from the different surveying parties have been very satisfactory.

Corps No. 1, Lieutenant M. M. Macomb, U. S. A., in charge, sailed from New York April 20, 1891, and arrived at Guatemala City May 9. The other officers of this party are Lieutenants Foote, Kennon, Rowan, Reber, Hedekin, U. S. A., and Mr. C. W. Haines, with Surgeon W. C. Shannon, U. S. A., as medical officer. The corps has since been augmented by the detail of four engineers whose services were tendered by the Government of Guatemala. Under date of July 29, 1891, Lieutenant Macomb reports that he is working toward the Mexican line, being encamped near Patulul. After completing the survey from Guatemala City to the Mexican line, he will return to Guatemala City and proceed southward with the survey through Central America.

Corps No. 2, in charge of Mr. William F. Shunk, sailed from New York April 10, 1891, and arrived at Guayaquil April 21, and at Quito May 7, 1891. The assistants in this party are Robert Burgess, William J. O'Connell, James Parker, Thomas F. Dempsey, D. M. Martinez, Jr., and Surgeon Frederick N. Ogden, U. S. N. Under date of July 12, from Ibarra, Ecuador, Mr. Shunk reports that he left Quito, June 3, and, although this is considered the most difficult part of the route, he had made an average of about 2½ miles per day, and at the time of writing was making about 4 miles per day, with the hope of increasing that speed. He estimates the average cost of the first 100 kilometers, for grading, masonry, and bridges, at $20,000, equivalent to about $32,000 per mile, and he had not used any gradient exceeding 3 per cent., which is about equal to 150 ft. per mile.

Corps No. 3, in charge of J. Imbrie Miller, accompanied Corps No. 2 as far as Quito and then commenced surveying to the southward toward Peru. The other members of this party are William D. Kelley, Jr., W. L. Wilson, J. D. Foster, J. R. Kurtz (the latter sailed to join the party on the 10th of August), and Surgeon C. W. Rush, U. S. N. Mr. Miller reports, under date of July 14, that his party was then 100 miles south of Quito, and a cablegram informs us that he had reached Cuenca, 160 miles south of Quito, on August 1; this is near the Peruvian boundary. He expects to maintain a speed of 100 miles per month over the route.

The Commission adjourned to meet in Washington during the coming winter, by which time it is expected that the several engineering parties will have reported on a considerable part of the route, including the most difficult portion.

Judging from the satisfactory conference with the delegates from the other republics last winter in Washington, and the cordial manner in which the surveying parties have been received and assisted, we are encouraged to believe that the republics generally will welcome and give substantial aid and protection toward the construction of the contemplated railway.

## TEXAS & PACIFIC STANDARD COAL CAR.

THE accompanying drawings show the standard 60,000-lbs. coal car of the Texas & Pacific Railroad; they are taken from the plans as prepared by Master Car-Builder W. D. Minton, under the supervision of M. W. Elliott, Superintendent of Motive Power and Rolling Stock.

Fig. 1 is an elevation of the car, one-half the length being shown in section and one-half in side elevation; fig. 2 is a plan, the flooring being omitted for half the length; fig. 3 is an end view; fig. 4 is a side elevation of the truck; and fig. 5 is one-half an end view and one-half a section of the truck.

The general dimensions of the car body are: Length outside of end sills, 34 ft. 8 in.; width outside of end sills, 8 ft. 9½ in.; distance from center to center of transoms, 25 ft.; distance from center to center of needle beams, 7 ft. The center sills are 9 in. apart; the first intermediate sills 3 ft. 2½ in. and the second intermediate sills 5 ft. 7½ in.

The longitudinal sills are 4¾ × 8 in. and 4¾ × 13 in., of yellow pine; the end sills 7 × 9 in., of white oak; the needle beams 5 × 9 in., of white oak, and the draft timbers 4½ × 8 in., of white oak. The coal sides are 40 in. in height above the platform, and are of yellow pine plank 2½ × 10 in., the side stakes being of 4¼ × 4½ in. white oak. The flooring is of pine 1¾ × 8 in., with ship-lapped joints.

The construction of the car body is well shown in the

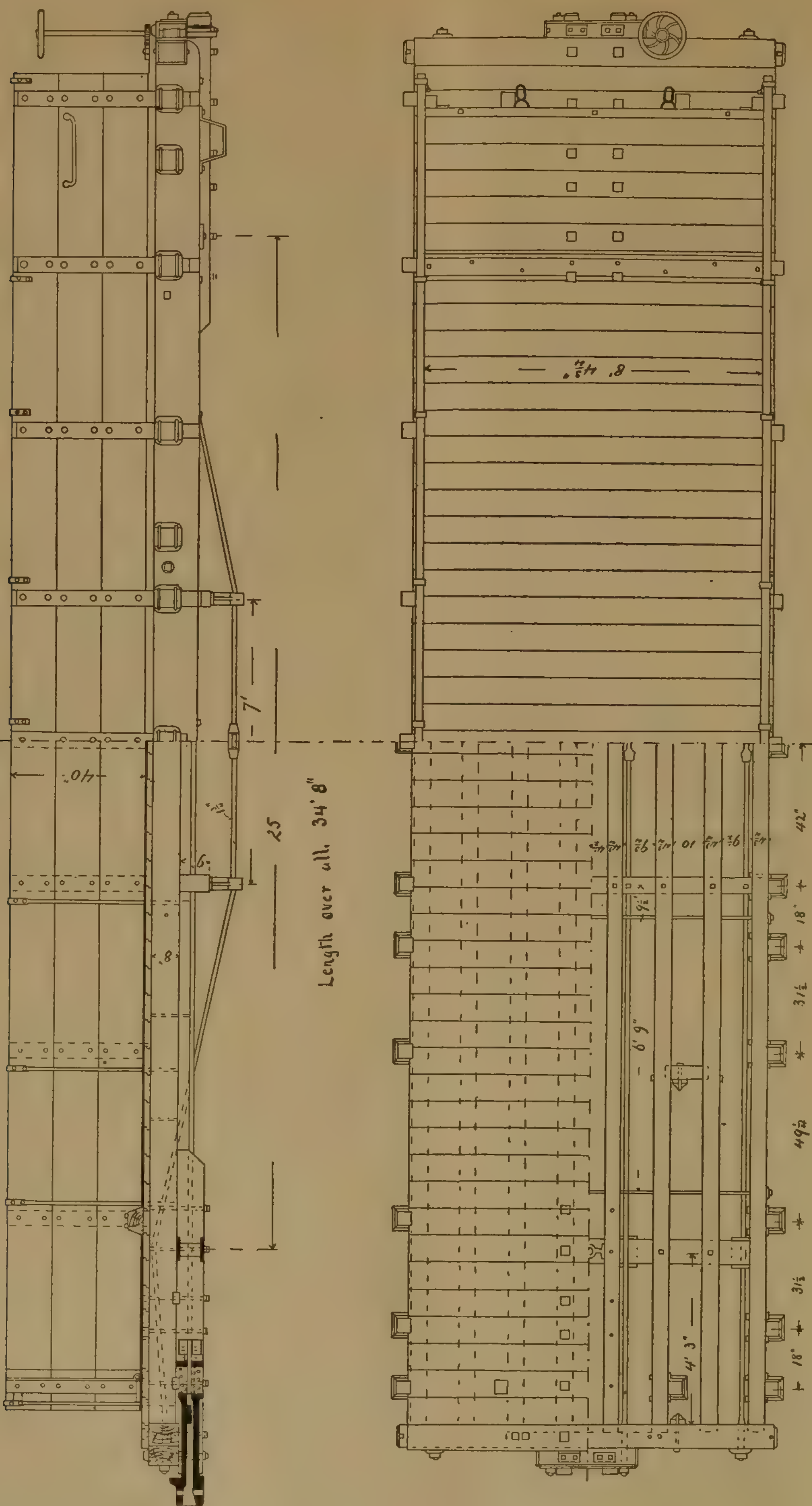



Fig. 1.

Fig. 2.

STANDARD COAL CAR. 60,000 LBS. CAPACITY, TEXAS & PACIFIC RAILWAY.

M. W. ELLIOTT, SUPERINTENDENT OF MOTIVE POWER AND ROLLING STOCK; W. D. MINTON, MASTER CAR BUILDER.

drawings. There are eight sills mortised and tenoned into the end sills, the latter being secured by four 1¼-in. truss rods. The long sills are further secured together by four ¾-in. cross rods. The body transoms are of 1 × 7-in. centers of arch-bars, 6 ft. 3 in.; between centers of springs, 6 ft. 3 in.; between centers of side-bearings, 4 ft. 10 in. The axles are of iron, of the M. C. B. standard pattern for 60,000-lbs. cars, being 4⅝ in. in

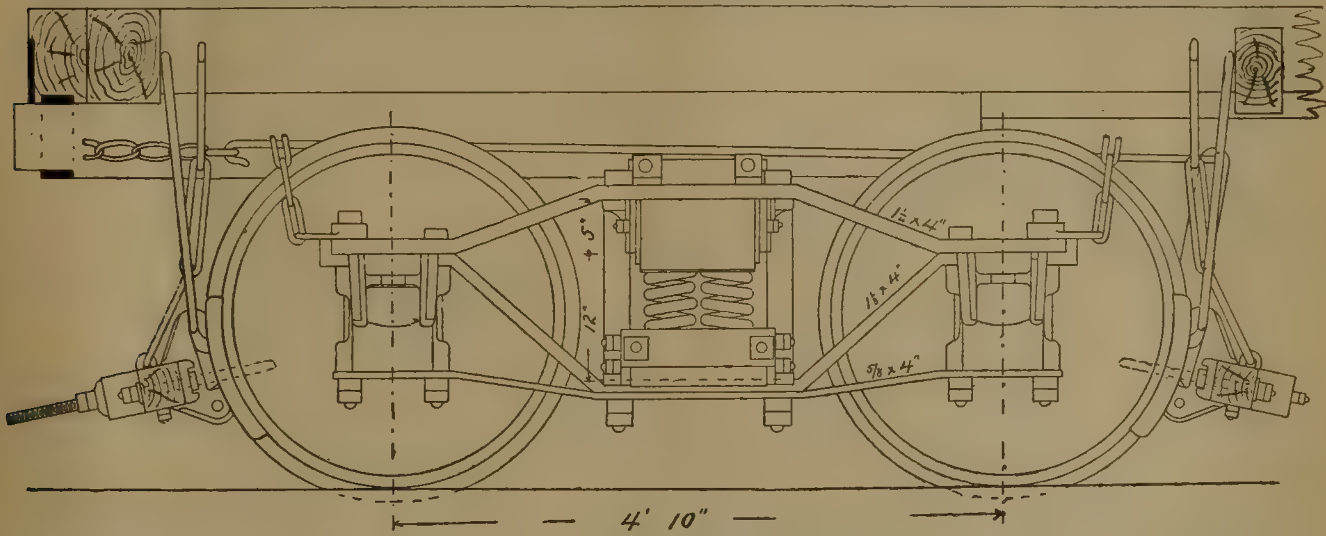



Fig. 4.

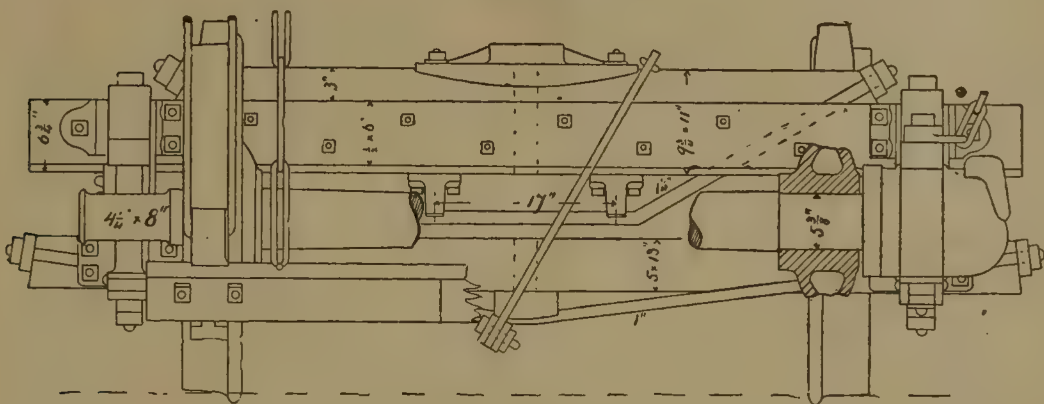



Fig. 5.

TRUCK FOR 60,000-LBS. COAL CAR, TEXAS & PACIFIC RAILWAY.

iron, properly secured by bolts. The draft timbers are secured to center sills and deadwood blocks by five 1-in. bolts, and are further supported by a carrier iron ⅝ × 3 in., bolted to the end sills.

The draw-heads are cast iron, with American draw-bar attachment. The continuous rods are 1¼-in. iron, looped

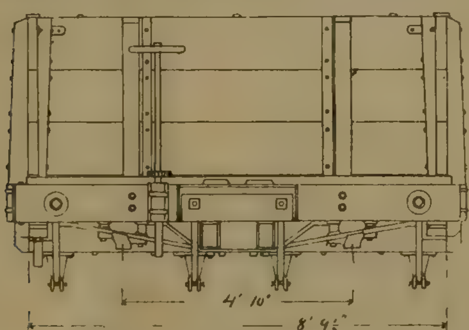



Fig. 3.

at the ends and secured by keys. The follower-plates are 1½ × 7 × 11 in., and the draw-springs are of steel, 6 × 6 in., two coil. The stake-pockets are of pressed steel. Steps, brake irons, etc., are of the usual pattern.

The trucks are of the rigid pattern, and are carried on four 33-in. double-plate cast-iron chilled wheels. The distance between centers of axles is 4 ft. 10 in.; between diameter at the center, 5⅜ in. at wheel-seat and 7 ft. 0¼ in. long over all, with 4¼ × 8-in. journals. The journal boxes are the M. C. B. standard type, with Hewitt lid, and have the M. C. B. standard lead-lined brasses, with malleable iron key. There are four safety chains to each truck.

The top arch-bars are 1¼ × 4 in., the bottom bars 1⅛ × 4 in. and the tie-bars ⅝ × 4 in. The top bolster is of white oak, 10 × 11 in. and 7 ft. 10 in. long, trussed with two 1¼-in. rods; the bottom sand-board is of white oak, 5 × 13 in. and 7 ft. 10 in. long, and trussed with two 1-in. rods. Each truck has two four-group bolster springs, 7 in. high. The center-plate is of steel, of pattern shown in the drawings, and the king-bolt is 1¾ in. in diameter and 23 in. long. The threads on all bolts are of the U. S. standard pattern.

The brake-gear is of the usual pattern, as shown in the drawings, and the brake-beams are hung from the car body.

The St. Charles Company at St. Charles, Mo., is now building 300 cars for the road from these drawings.

## A PROBLEM.

THE following has been submitted for solution by Mr. Aloha Vivarttas, of New York. It may be said that it has a practical application in designing.

*Proposition.*—A pyramid has the following properties:

1. The angle of each of the sides at the apex equals $x$.
2. A section on any plane in which lies the angle formed by two adjacent sides has the same angle $x$ at the apex.
3. Any section perpendicular to any one of the sides or their angles has all of its angles, except those at the base, each equal $x$.
4. Any section parallel to any one of the sides or their angles has all of its angles, except those at the base, each equal $x$.

*Required:*

1. The angle $x$.
2. Number and description of sides.
3. Form of base.
4. Cubic content.

Answers to this problem from any correspondent will be acceptable.

## PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page* 465.)

### WINGS AND PARACHUTES.

The earlier adventurers upon aerial enterprises possessed little accurate knowledge of the properties of air. They had only their observations of the birds as a guide, and knew of no motive power save that derived from muscular energy; hence their thoughts first turned to flapping wings, to be propelled by their own exertions. Some few, as we shall see, have considered the force of the wind, but it is only since the age of steam that artificial motors of any kind have been proposed for flying machines.

The well-worn legends of antiquity, concerning *Dedalus*, *Abaris*, *Archytas*, etc., may be passed over without comment. They merely indicate how the problem of artificial flight appealed to the imagination of men from the earliest periods, but some curious traditions will be mentioned, indicating partial successes in soaring flight, when we come to treat of aeroplanes.

About the first authentic account which we have of a proposal to provide man with flapping wings seems to be due to *Leonardo da Vinci*, the painter, sculptor, architect, and engineer. He is said not only to have experimented with aerial screws made of paper, and to have designed a parachute, but also to have seriously contemplated building an apparatus to propel a pair of wings, of which several sketches have been found in his note-books.

The first sketch shows a wing, actuated by the arms, but *Da Vinci*, becoming aware, upon reflection, that all possible muscles of man must be brought into play to act effectually upon the air, designs in the second and third sketches an apparatus in which the wings are to be waved downward by the legs and lifted up by the arms. The third sketch is represented in fig. 2. In this *Da Vinci* only shows the legs in place, so as not to obscure the construction of the parts. The date is probably about the year 1500. The construction is simple, and might not prove altogether inefficient did the muscles of man possess the same energy and rapidity of action as do those of birds in proportion to their respective weights. It is not known just how far *Da Vinci* elaborated his idea, but he never put it to practical test, and it is chiefly mentioned here as a curious forerunner of actual experiments.

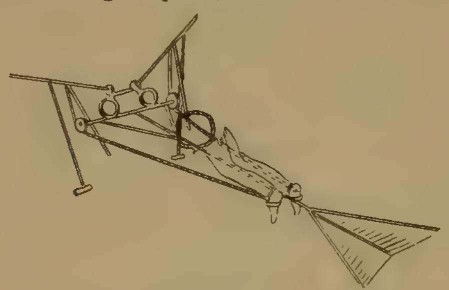


Fig. 2.—LEONARDO DA VINCI—1500.

The first wing experiment reported by tradition seems to be that of a French tight-rope dancer named *Allard*, who, under the reign of Louis XIV., announced that he would fly from the terrace at Saint Germain toward the woods of Vesinet in presence of the king. It is probable that he had previously succeeded in gliding short distances, but upon trial before the court his strength failed him; he fell near the foot of the terrace, and he was grievously hurt.

This probably occurred about the year 1660, and in 1678 a French locksmith named *Besnier* constructed a pair of oscillating wings, approximately represented in fig. 3.

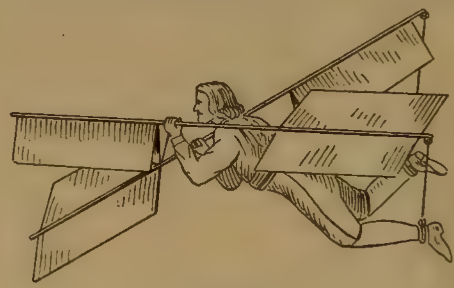


Fig. 3.—BESNIER—1678.

The apparatus consisted of two bars of wood hinged over the shoulders, and carrying wings of muslin, arranged like folding shutters, so as to open flat on the down stroke and fold up edgewise on the up stroke. They were alternately pulled down by the feet and by the arms, in such wise, that when the right hand pulled down the right wing, the left leg pulled down the left wing, and so on, thus imitating the ordinary movements in walking.

*Besnier* did not pretend that he could rise from the ground or fly horizontally through the air. He only tried short distances; having begun by jumping off from a chair, then from a table, then from a window-sill, and next from a second story, and finally from the garret, on which occasion he sailed over the roof of an adjoining cottage. He gradually grew more expert, sold his first pair of wings to a mountebank, who performed with them at the fairs, and he expected with his second pair to fly across moderately wide rivers by starting from a height, but it is not known whether he ever performed this feat.

The illustration is evidently an imperfect sketch made from a description; for the hinging at the shoulder is not shown, the attachment for pulling down the wings with the legs is evidently inefficient, and the supporting surfaces are entirely inadequate. The four wings are apparently each 3 ft. by 2 ft; say, an aggregate of 24 sq. ft. in area, while in the table of birds, to be given hereafter, it will be seen that the duck, which has the smallest bearing surface in proportion to its weight, measures 0.44 sq. ft. to the pound, and at this rate a man, weighing, say, 150 lbs., would require wings aggregating 66 sq. ft. in area. It is probable that *Besnier* had even more than this, that he took short downward flights aided by gravity, but that he utterly failed when he undertook to go considerable distances.

It is not stated whether the *Marquis de Bacqueville* had engaged in similar preliminary practice when he announced, in 1742, that he would, on a certain day, fly across the river Seine from his mansion, situated in Paris on the quay at the corner of the Rue des Saints Pères, and alight in the Tuilleries, a distance of 500 or 600 ft. A large crowd having assembled on the appointed day, the marquis, with large wings attached to his hands and to his feet, launched himself into space from the summit of a terrace jutting out from one side of the mansion.

For a space he seemed to get along well, but soon his movements became uncertain, he faltered, and then he fell, alighting upon the deck of a washerwomen's barge a short distance out into the stream. He broke his leg in the fall, and never attempted the feat again.

The *Marquis de Bacqueville* was judicious in trying the experiment over a water-bed, for could he have held out but a few feet further he would probably have escaped with a mere ducking. He probably glided about 120 ft.

with most violent exertions, and fell when his strength became exhausted. Fig. 4, which is probably incorrect, represents the traditional apparatus with which this feat was attempted. The surfaces measure about 24 ft. in area, and are quite insufficient to sustain the weight of a man.

Aware of this experiment of *De Bacqueville* and of its consequences, the *Abbé Desforges*, a canon of the church at Sainte-Croix at Étampes, invented, in 1772, a flying chariot,

FIG. 4.—DE BACQUEVILLE—1742.

with two wings and a small horizontal sail or aeroplane attached, which from contemporary descriptions seem to have measured about 145 sq. ft. in aggregate area. He expected to rise from a height of a few feet above the ground, and to fly horizontally by rapidly beating his wings. Upon actual trial, the machine being held aloft by four men, the *Abbé* flapped violently, but utterly failed to start off. Indeed, some of the accounts say that the action of the wings pulled him down instead of up, so that he got a harmless tumble when the men let go.

In 1781, *Blanchard*, who subsequently became a fervent aeronaut, and who was the first to cross the British Channel in a balloon, constructed near Paris a flying chariot with four wings, measuring in the aggregate some 200 sq. ft. in area. He never exhibited the apparatus in public, having probably ascertained by private experiment that he was unable to move the wings rapidly enough to produce any useful effect.

These last two experiments, taken in connection with those previously mentioned, exhibit fairly well the two horns of the dilemma that confront inventors who endeavor to provide man with wings to be worked by his own muscular power. Either those wings have to be relatively small, in order to permit their being waved rapidly—and then they do not afford sufficient supporting area—or if they are made to approximate to the proportion which generally obtains with birds, or about one square foot to the pound, they become so large that the man does not possess the muscular power to wave them at any adequate speed.

Ideas, however, die hard, and we may disregard somewhat the chronological order of date, in order to follow the evolution of the small-wing idea, which each fresh inventor fancies has been incorrectly worked out by his predecessors.

Of these was *Bourcart*, who in 1866 experimented with the apparatus shown in fig. 5. It consisted of four wings with a feathering action, so that it presented the edge to the air upon the up stroke and the broad side upon the

FIG. 5.—BOURCART—1866.

down stroke, but the results were insignificant, and the experiment was abandoned. The supporting areas measure approximately some 36 sq. ft., but are only effective upon the down stroke.

In 1873 Professor *Pettigrew* published his work on "Animal Locomotion," in which he called attention to the fact that birds in flapping flight, flex their wings so as to resemble a screw propeller, and that the tips describe a figure of 8 motion. This led to the inference that man had not succeeded in raising himself with wings because he had not hit upon the right motion, and in 1879 *Dandrieux* constructed an apparatus in which the wings were attached to an oblique axle, so as to describe a figure of 8 movement. This is represented in fig. 6, and there

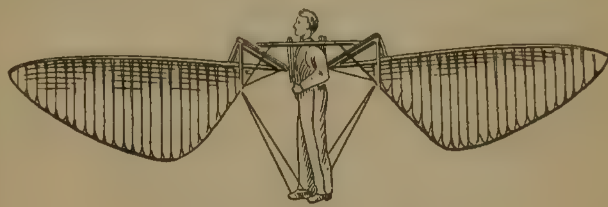


FIG. 6.—DANDRIEUX—1879.

being but two wings in place of four, the supporting surfaces measure about 32 sq. ft. in area. The result was not satisfactory; a partial alleviation of the weight was obtained, but nothing like human flight or the hope of it.

A much more successful experiment had, however, previously been made at the first Exhibition of the Aeronautical Society of Great Britain, held at the Crystal Palace, in London, in 1868. Mr. *Charles Spencer* exhibited an apparatus consisting of a pair of wings measuring each 15 sq. ft. in area, to which was attached an aeroplane measuring 110 ft. more, and also a tail like a boy's dart, and a longitudinal keel-cloth to preserve the equilibrium, the whole weighing 24 lbs. and giving a sustaining surface of 140 sq. ft. As Mr. *Spencer* was an athlete, he was enabled, by taking a preliminary run down a little hill, to accomplish short horizontal flights of 120 to 130 ft., in which he was wholly sustained by the air. He weighed 140 lbs., and his apparatus, which, it will be noted from the description, differed from those which propose "wings for man" by the addition of an aeroplane, measured 0.85 sq. ft. to the pound, or about the proportion of the larger soaring birds. The experiments attracted great attention at the time, but were not sufficiently encouraging to warrant pursuing the matter further.

At the same exhibition Mr. *W. Gibson* showed a machine consisting of two pairs of wings, worked by the hands and feet together, so as to impart a feathering movement similar to that of birds. He stated that in a former machine, having only one pair of wings of lighter construction, their action upon the air during a vigorous down stroke was sufficient to raise the man and machine; but no practical demonstration was given, and although the inventor stated that he was then engaged in constructing a more perfect machine, nothing more has been heard of it.

Notwithstanding these many failures, the idea does not seem to be dead yet, for in September, 1890, Mr. *W. Quartermain*, who exhibited an explosion engine for aerial purposes in 1868, in which the motive power was derived from the gases generated from a species of rocket composition, wrote a letter to the London *Engineer*, in which he stated that he had abandoned his attempts to procure a light and energetic motor from hydrocarbonous matter, in favor of man's weight and muscular power, which he considers preferable, and was then engaged in experimenting with an apparatus consisting of four wings, formed after the stag beetle type, each 10½ ft. long by 2¼ ft. wide, opposing 90 sq. ft. of expanse of surface to the air. This arrangement weighed 350 lbs., including 212 lbs. for the weight of the operator, who by working both handles and treadles, thus bringing all his muscles into action as well as his weight, was enabled to wave the wings, which are 25 ft. from tip to tip, so as to produce a double stroke for every single stroke of his body on the motive shaft. He describes the result as resembling that of domestic fowls flapping their wings without lifting themselves from the ground, but is of opinion that the uplifting force was greater than his weight of 212 lbs., and believes that further improvements in the mechanism, with more skilful workmanship, might produce an ascensive force greater

than the whole weight of 350 lbs. This may well be doubted, for not only will it be shown hereafter that the energy of man must be less than that of birds, but none of the latter fly with so small a bearing surface in proportion to the weight—0.26 square foot to the pound—as in *Quartermain's* apparatus.

It has been suggested, however, that umbrella-like surfaces might prove more effective than wings, and increase the uplift to be derived from the air. Such contrivances were experimented upon by *Sir George Cayley*, who constructed, about 1808, a pair of wings which appear from the drawings to have been a fabric stretched tightly over a dished frame, this framework consisting of two ribs at right angles to each other, bent and tied across so as to secure rigidity. This double umbrella contained 54 sq. ft. and weighed only 11 lbs., and the inventor says: "Although both these wings together did not compose more than half the surface necessary for the support of a man in the air, yet during their waft they lifted the weight of 9 stone" (126 lbs.). It is not stated with what speed they were wafted nor with what power, but that the result did not promise to provide "wings for man" may be inferred from the fact that *Sir George Cayley*, in a very valuable series of articles in *Nicholson's Journal* for 1809 and 1810, starts out with the assertion that, in order to accomplish aerial navigation, "it is only necessary to have a first mover which will generate more power in a given time, in proportion to its weight, than the animal system of muscles."

The next experiments with umbrella-like wings attracted attention all over Europe. They were carried on by *J. Degen*, a clockmaker of Vienna, from 1809 to 1812, with the apparatus shown in fig. 7. It consisted of two wings 8½ ft. wide and 22 ft. across in the aggregate, each being shaped somewhat like a poplar or an aspen leaf.

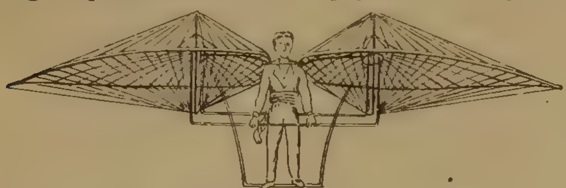


Fig. 7.—DEGEN—1812.

They were stretched upon an umbrella-like frame and thoroughly braced back, both above and below, to a central stick by a number of small cords. The supporting surfaces consisted of bands of taffeta so attached as to have a valvular action, in order to imitate the supposed action of the feathers of birds, and the total supporting surface was 130 sq. ft., while the weight, without the operator, was stated at 20 lbs.

With this apparatus *Degen* was stated, in 1809, to have risen to a height of 54 ft., by beating his wings rapidly, in presence of a numerous assembly in Vienna, and all the newspapers began to publish accounts of the performance.

These descriptions failed to mention one important addition. *Degen* was also attached to a small balloon capable of raising 90 lbs., so that the uplift exerted by the wings was only 70 lbs. of the 160 lbs. weight of the operator and his apparatus.

In 1812 *Degen* went to Paris to exhibit his invention. He then stated that the balloon was of no sort of utility in obtaining headway, but that it was necessary as a counterpoise to maintain his equilibrium and to lighten his muscular efforts. He evidently expected by the action of his wings to drag the balloon along in still air while it lifted part of his weight.

He gave three public exhibitions in Paris, but unfortunately for him, as there was wind upon each occasion, he was blown away, and on the third attempt he was attacked by the disappointed spectators, beaten unmercifully, and laughed at afterward as an impostor.

The umbrella idea had, however, previously proved to be of value for parachutes, and in 1852 *Letur* devised the apparatus shown in fig. 8, with which he expected to direct himself through the air, by means of the wings and tail, first starting from an elevation.

In 1854 he ascended from Cremorne Gardens in London, suspended about 80 ft. below a balloon manœuvred by Mr. Adam, the areonaut, who was assisted by a friend. *Letur* performed several evolutions in the air by means of his wings, none of them apparently very conclusive; but

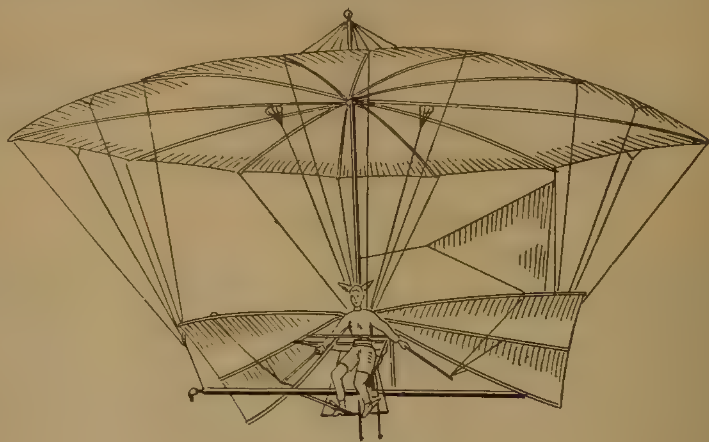


Fig. 8.—LETUR—1852.

in coming down near Tottenham, the wind carried the apparatus violently against some trees, and poor *Letur* received injuries which resulted in his death.

His apparatus measured about 660 sq. ft. in bearing surface, and had he been entirely detached from the balloon, it is possible that he might have reached the gound in safety; but it is evident that his wings would have been of little service in enabling him to obtain more than a slight horizontal direction.

Undeterred by this sad fate, a Belgian shoemaker named *De Groof* designed, in 1864, an apparatus which was a sort of cross between beating wings and a parachute. His plan was to cut loose with it from a balloon, and to glide down in a predetermined direction by manœuvring the supporting surfaces. He endeavored to make a practical experiment, both in Paris and in Brussels, but it was only in 1874 that he succeeded in doing so in London.

The apparatus is shown in fig. 9. It consisted of two wings, each 24 ft. long, moved by the arms and the

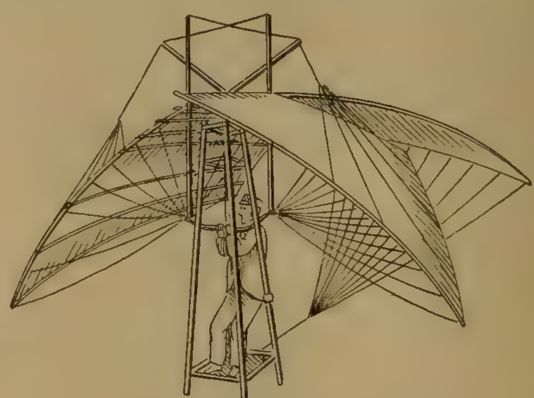


Fig. 9.—DE GROOF—1864.

weight of the operator, and of a tail 20 ft. long, which could be adjusted by the feet.

*De Groof* first went up on June 29, 1874, from Cremorne Gardens, London, attached to the balloon of Mr. Simmons. He came down safely, and claimed to have cut loose at a height of 1,000 ft., but it was subsequently stated by others that in point of fact he had not, upon this occasion, cut loose at all, but had descended still

attached to the balloon. In any event, he went up again on July 5 following, with the same aeronaut, and on this occasion he really did cut loose.

The result was disastrous. As soon as, in the descent, pressure gathered under the moving wings, they were seen to collapse together overhead and to assume a vertical position, when *De Groof* came down like a stone, and was killed on the spot.

Had the wings been prevented from folding quite back, by means of suitable stops, the descent might not have proved fatal. The area of the wings and tail, as extended horizontally, is said to have amounted to 220 sq. ft., while the weight of the man and machine was 350 lbs., or at the rate of 0.65 square foot to the pound. This corresponds to a pressure of 1.54 lbs. to the square foot, which would be generated by a velocity of 25.7 ft. per second, or a free fall from a height of 10.3 ft.; an unsafe distance for an ordinary person, but not for a trained acrobat.

Ordinary parachute practice is said to allow from 2 to 3 sq. ft. per pound, corresponding to velocities in falling of 14.7 to 12 ft. per second.

It was the most egregious folly for *Letur* and *De Groof*, as well as for *Cocking*, who was killed in 1836 in an experiment with a parachute shaped like an inverted umbrella, to attempt a descent with an apparatus previously untried to test its strength and behavior. A few prior experiments, with a bag of sand, instead of the man, would have exhibited the action that was to be expected.

Another class of inventors of "wings for man" have endeavored to secure safety by the use of large bearing surfaces. The first of these was probably, *Meerwein*, architect to the Prince of Wales, in 1784, who proposed an apparatus shaped like the longitudinal section of a spindle, separated into two wings, by a hinge at the center. It measured nearly 200 sq. ft. in area, and probably was never tried, but if it had been, it is quite certain that a man could never have imparted to the wings sufficient velocity to perform any useful effect.

The next proposal of this class was that of *Bréant*, who

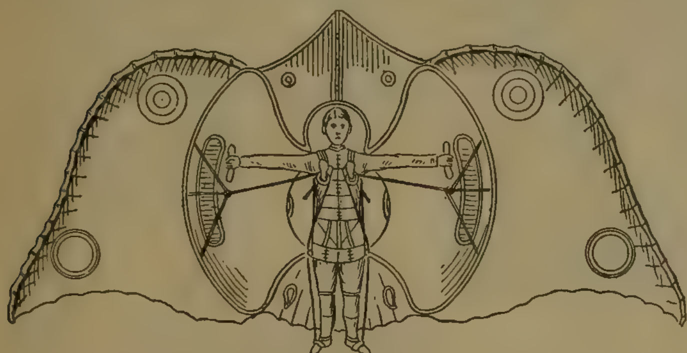


FIG. 10.—BRÉANT—1854.

designed in 1854 the apparatus shown in fig. 10. It consisted of two wings, each measuring about 54 sq. ft. in area, and provided with three valves to relieve pressure on the up stroke. The down stroke was to be produced by the joint action of the feet and hands, and the wings were to be drawn back by elastic cords. It is not known whether it was ever tried, but it would have proved ineffective if it had been.

The next design was that of *Le Bris* in 1857, which is exhibited by fig. 11. By noting the little man working the levers in the center, the proportions of the apparatus, which seems to have measured some 550 sq. ft. in area, will be appreciated. It is said to have been experimented with in a small model, in which levers pulled down the wings which were then drawn back by springs, but it did not succeed in rising into the air, as was hoped by the inventor.

Before proceeding to describe other designs for winged machines, to be driven by artificial motors instead of muscular power, it may be well to call attention to the fact that not only has every attempt of man to raise himself on the air by his own muscular efforts proved a complete failure, but that there seems to be no hope that any amount of ingenuity or skill can enable him to accomplish this feat.

It has been argued that there is no proof that, weight for weight, a man is comparatively weaker than a bird, and that, inasmuch as he can raise his weight in walking up a stairway, he should be able to raise it by acting upon the air with a suitable apparatus. The weak point about

FIG. 11.—LE BRIS—1857.

this argument is not only that the weight and bulk of such an apparatus become a surcharge on the muscular power of the man, as would be, for instance, the case were an artificial pair of wings applied to an ostrich, but that among the birds themselves the power to rise vertically unaided does not exist for the larger species. These have to resort to various artifices, such as running against the wind or dropping from a perch, in order to gain that initial velocity which enables their surfaces to derive support from the air, and this probably furnishes a good reason why no flying birds exceed some 50 lbs. in weight; for small animals must possess more energy in proportion to their size than large ones.

Assuming that the speed of contraction in the muscles of two similar birds of different sizes is the same, it is evident that the work done per unit of time will be in ratio to the sectional area, or as the square of the dimensions, while the weight to be moved will vary as the cube of the dimensions; hence the rate of increase between the energy and the weight will be:

$$\sqrt[2]{\text{Energy}} \quad \text{varies as} \quad \sqrt[3]{\text{weight}},$$

or to put it in the shape of formulas which shall express the relative energy of animals of the same class:

$$E \propto \sqrt[\frac{3}{2}]{w} \quad \propto \sqrt[1.5]{w} \quad \propto W^{\frac{2}{3}}$$

These being all merely different ways of writing it. Hence we see that the energy of birds will only increase as the $\frac{2}{3}$ power of their weight, and that there will be an increase of size beyond which they will not be able to develop the work required for a start.*

But man is also at a further disadvantage. Not only do birds have an enormous muscular development, but their muscles contract at a much more rapid rate than those of other animals. Were men, therefore, not already relatively weaker than smaller animals, in consequence of the physical law which has been stated, they would still be unable to develop energy fast enough to rise on the air with a pair of wings. They can raise their weight, it is true, but not as quickly as the birds. They can run up a stairs at the rate of about 3 ft. per second, while the sparrows rise up vertically at thrice that speed, and fly horizontally at 22 ft. per second.

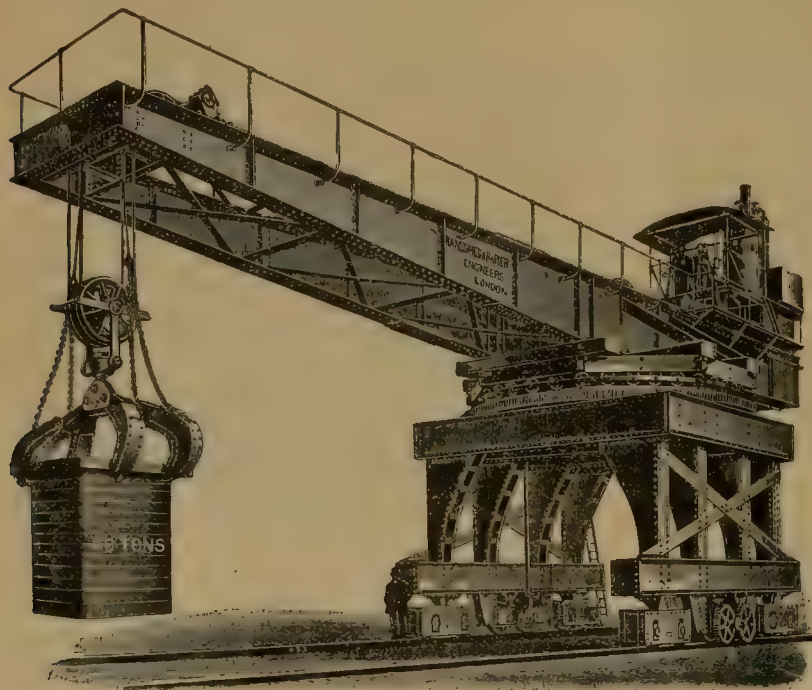
(TO BE CONTINUED.)

* Thus a bird of 50 lbs. weight can do no more work in a given time than $50^{\frac{2}{3}} = 13.57$ similar birds each weighing 1 lb., or a bird of 1,000 lbs., did such a one exist, could only develop the same number of foot-pounds per minute as the aggregate of 100 analogous birds, each of 1 lb. weight.

## A LARGE STEAM CRANE.

THE accompanying illustration, from *Iron*, shows a steam "Titan" crane lately completed by Ransomes & Rapier, of Ipswich, England, for the harbor works at Madras, India. It is intended to lift concrete blocks weighing 32 tons each, which are used in building the breakwater. In the illustration it is shown lifting the test load of 40 tons.

All the motions of the apparatus are controlled by a set of levers placed on the platform within easy reach of one man, who has absolute control of every movement of the machine. Its actual weight, without water-ballast or load, is 152 tons, so that when it is traveling with its 40 tons of load and its water-ballast there are 210 tons absolute weight in motion. The momentum is therefore very great, and provision had to be made to reduce this force gradually. The slewing-round gear, for instance, is remarkably free, and 40 tons moving round at a radius of 50 ft. would acquire a momentum much in excess of the actual weight. To provide for easing off this force, spring drivers are introduced in various portions of the gear, and their operation is so successful that the driver may set his engine at full speed in one direction, and then reverse the friction cones to drive in the opposite direction, the engine still running at full speed. Even with such a severe test, no shock is perceptible in any part of the gear. The load swings round in a forward direction for some little time after the gear is reversed; it then comes gradually to a stop without any perceptible jerk, and as gradually starts off in the opposite direction, also without shock.



TITAN STEAM CRANE, MADRAS HARBOR WORKS.

The gearing which causes the crane to travel on the rails is also provided with spring drivers, which enable the engines to make several revolutions before the "Titan" begins to travel, the power having been gradually accumulated in the spring drivers, and as gradually given out. Several other important features are embodied in this "Titan." It has not only, for instance, to swing all round the circle with a full load, but it must also, owing to the shape of the breakwater upon which it is to be employed, be able to travel upon a curved road. To secure this result, the "Titan" is placed upon 12 wheels, in three groups of two each on either side. The outer groups at the four corners are on pivoted trucks; the central groups only are driven, and by means of differential gear on the Jack-in-the-box principle the wheels on the outer curve can travel over a greater distance than those on the inner curve, although both are driven by the same engine. The machine in this respect has been tested in the yard on a curve of 90 ft. radius, and found to answer admirably. The blocks with which the "Titan" will have to deal are seized in powerful claws, which close automatically on the load and raise it by sheer power of grip. When these blocks are suspended over the position they are intended to occupy, there is another automatic appliance by which the claws are made to release their hold. In this way the foundations of the new structure will be laid under water. Subsequently, when more accurate work will be required, the blocks of concrete will be gently lowered down, and adjusted upon the prepared foundation. The "Titan" is made of mild steel, and all the parts are carefully machined and put together with turned fitting bolts, the rivet holes being accurately drilled.

## A NEW QUADRUPLE-EXPANSION ENGINE.

THE illustration herewith shows a quadruple-expansion engine, designed by Mr. Frank Chaese, of Hartford, Conn. It is reproduced from a photograph of a complete model made by Mr. Chaese on a scale of $\frac{3}{4}$ in. = 1 ft., which exactly represents the larger engine. The dimensions of the model are: cylinders, $\frac{7}{8}$ in., $1\frac{3}{8}$ in., 2 in. and $2\frac{1}{8}$ in. diameter, and $1\frac{3}{4}$ in. stroke. The engine represented has cylinders 14 in., 22 in., 32 in. and 45 in. diameter and 28 in. stroke, and is intended to work with a boiler pressure of 200 lbs.

As will be seen from the cut, the engine is of the vertical, inverted type, with cylinders arranged in pairs. The aim of the inventor has been to make an engine which will still be serviceable after any ordinary accident while at sea. A system of duplication of parts has been carried throughout, and every piece is readily accessible for adjustment or repair, while the space required for the engine, both fore-and-aft and vertically, has been reduced to a minimum. The bearing surfaces are all unusually large, and well supplied with means of lubrication; also with a water service having universal joints for all parts, and hose connections for emergencies.

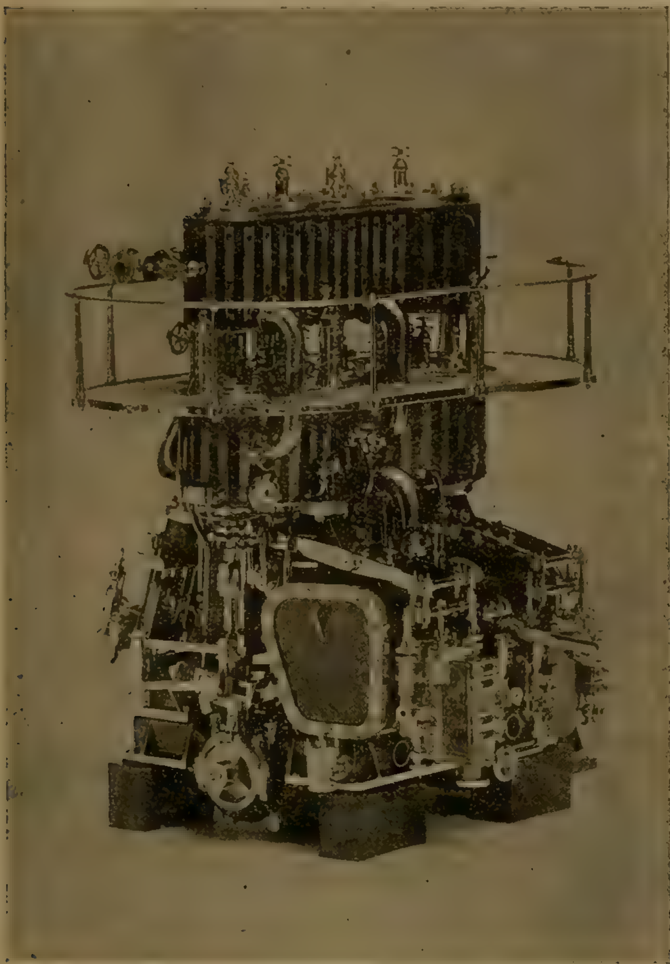
The engine is on the tandem principle, and constitutes two distinct engines, either of which may be used independently of the other in case of breakdown. The high-pressure and first intermediate cylinders form the forward engine, the second intermediate and low-pressure cylinders the after engine.

The crank shaft is made in two similar sections, flanged and connected in the center with a dowel having ample surface, in place of the ordinary coupling bolts; this greatly facilitates disconnecting the engines. In case the forward engine breaks down, the dowel is removed from the shaft and steam let into the after engine through a reducing valve. The after engine then runs as a compound condensing engine. Should the after engine be disabled, the connecting rod is removed from the crank-pin and secured out of the way; connection is made between the first intermediate exhaust and condenser, and the forward engine then runs as a compound condensing engine. The lengths of crank shaft are short, and a spare length is of course carried to provide for accident in this direction. All the necessary valves for these changes are provided. The throttle valve, combined, reducing and blow-through valve, cylinder drain cocks and reversing levers are all worked from the starting platform.

The cylinders are steam-jacketed and dripped into the condenser; they have also a coat of asbestos and a neat wood lagging. Relief valves of ample area are attached to each end of the cylinders, also the necessary indicator

cocks and connections. The main valves are all piston valves, the upper portion being made slightly larger in area than the lower portion ; this perfectly balances all the valve gearing.

The cylinder pistons are attached to their rods by an



CHAESE'S QUADRUPLE-EXPANSION ENGINE.

adjustable screwed collar and nut, which arrangement is quite rigid, but in case of accident allows the pistons to be easily removed ; the lower rods may also be made smaller by this method than by the usual tapered form.

The upper cylinders are supported on six short wrought-iron columns, any one of which may be readily removed for packing stuffing-boxes, examining or adjusting pistons or valves.

Split stuffing-boxes and collar bushes are used between the upper and lower cylinders. The long sleeve serves as an excellent guide to the piston rods, while one set of four stuffing-boxes is dispensed with and the vertical height of the engine reduced.

One of the forward columns of the A-frame is used as an oil reservoir ; the go-ahead slides are detachable, the shoes are broad and long and fitted with combs dipping into oil boxes at the foot of the guides in addition to the oil syphon pipes above.

The engine counter is simple in construction, but reliable. It is attached to the after column.

The valve gearing is a modification of the Allen straight link. The link is suspended in such a manner that the slipping of the block in the link is greatly reduced, and a quicker admission and cut-off effected. Reversing is done either by steam or by hand. The hand arrangement is a small force pump connecting to the same oil vessel and levers as the steam reversing gear, a few strokes of the hand-pump being sufficient to reverse the engine.

The steam reverser consists of a steam and an oil cylinder connected together and giving motion to the valve spindles and links. A lever to the steam cylinder, and a two-way valve to the oil cylinder allow the engine to be reversed at will and the cut-off fixed immovably at any point.

In connection with this reversing gear is a positive and very sensitive governor, which has complete control over the main engine at all times through the medium of the links, though it does not interfere with the easy starting, stopping and reversing of the engine. All the eccentrics are keyed on to the shaft in the usual manner, excepting the forward engine go-ahead eccentric. The lead of the latter may be varied according to judgment by a simple device, which is perfectly rigid when locked.

The condenser, it is claimed, is very efficient. Water from the circulating pump is discharged in two directions—around the jacket and through the tubes. Large, easily accessible doors, manholes and handholes are provided ; also a shifting valve at the lowest point. The hot-well has water gauges, vapor pipe and manhole, and forms part of the condenser casting.

All the pumps are worked from the main engine. There are two feed-pumps and two bilge-pumps. Either feed-pump is sufficient for the boiler under ordinary circumstances. They are placed considerably below the hot-well so as to be always flooded, and are provided with stop valves, relief valves, air vessels and pet-cocks. The bilge-pumps are likewise so provided.

The air pump is single-acting, and is placed low down on the condenser to avoid trouble in working.

The circulating pump is double-acting, and of ample capacity for water of all temperatures, the main injection valve being readily accessible. Pipes about the pumps are dispensed with as far as practicable, short passages being cast in the barrels.

There is an auxiliary engine bolted to the bed-plate, a worm from which engages with a wheel on the main shaft. A swinging bracket and clutch allow the worm to be thrown out of gear instantly, as this arrangement is only designed for turning the main engines when overhauling, etc. This auxiliary engine can be used as a powerful pump for all purposes, suitable connections being made to condenser, hot-well, sea and bilges.

Reversing is effected by one lever reversing the steam, cams on the shaft giving the necessary lead and cut-off to the balanced valves, while the absence of connecting and eccentric rods make a remarkably compact machine.

The thrust block has a double set of conical rollers running in oil, which take the full thrust of the propeller. Adjustable plates fore and aft take up the wear.

The general design of the remaining details of the engine is in accordance with modern practise. The model itself is a remarkable piece of work, all the details of the engine being faithfully carried out.

The engine itself appears to be of a very neat and compact design, and to possess some points of excellence which deserve the attention of builders.

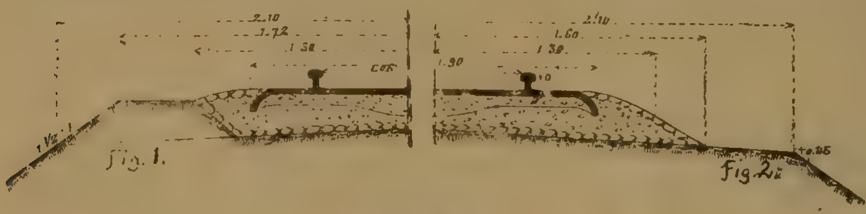
## THE SUMATRA STATE RAILROAD.

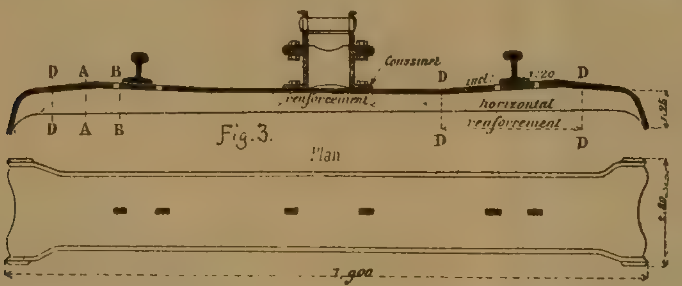
THE first railroad in the island of Sumatra, which is now nearly completed, has been built by the Dutch Government, and a long and interesting account of it is given by Chief Engineer J. W. Post in the *Revue Generale des Chemins de Fer*.

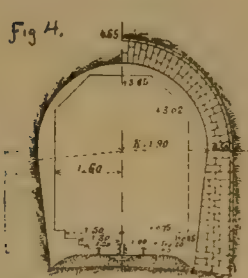
The road extends from Port Emma, the chief Dutch port on the island, to the coal mines of Lounto, with a branch from Padang-Pandjang to Fort de Kock. The line is a very circuitous one, as it was necessary to cross the Barisan mountain range. At Lounto mining has begun on an extensive scale, as the existence there of wide seams of coal of a very fine quality has been proved, and already large quantities have been taken out. In addition to the traffic of these coal mines the road carries a large quantity of

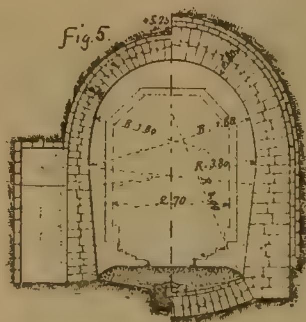
rice, coffee and tobacco from the fertile and thickly peopled districts of Solok and Payacombo, and has already developed a considerable passenger business.

The length of the main line from Port Emma to Lounto is 98 miles, and the branch to Fort de Kock is 12 miles long. The main line is divided into five sections, on three of which the traffic is worked in the ordinary way; on these sections the maximum grade is 1.7 per cent. On the other two sections there are grades as high as 8 per cent., and on these a rack-rail is used. The mountain sections are in all 33 miles long, and there are on them 18 miles of rack-rail in sections varying from 650 ft. to 3½ miles in length. The minimum radius of curvature is 492 ft.



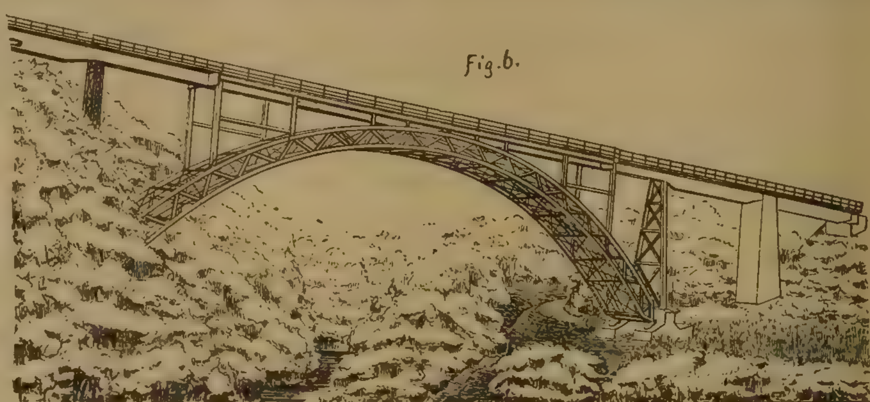

On the main line Lounto is 827 ft. above sea level; the summit is at the Padang-Pandjang Pass, and is 2,532 ft. above the sea. On the branch Fort de Kock is 482 ft. above Padang-Pandjang, and to reach it the line has to pass over the Merapi Pass, where the summit is 3,785 ft. above the sea. On this branch, however, there is no heavy freight, like coal, to be transported.

The line is of 1-meter gauge. The rails are of steel, laid on steel ties. Wood is abundant along the line, but the rapid decay incident to the tropical climate prevents its use. The ballast is generally broken stone. On the level sections in the valleys the line had to be raised on an embankment almost everywhere, to keep it out of danger from floods. Wherever possible the slopes of the embankments are protected by rip-rap. The method of laying and ballasting the road-bed is shown in figs. 1 and 2, fig. 2 being a half section of the normal road-bed, and fig. 1 a half section showing the track at points exposed to inundation. The figures on all the drawings are in meters.

Fig. 3 shows a section and plan of the tie and track where the rack-rail is used. The racks, it will be seen, are bolted to special chairs attached to the center of the tie.

There are two tunnels on the line. The first is 230 ft. long, and is chiefly in solid rock, masonry lining being required for only a short distance. Cross sections of this tunnel are shown in fig. 4, in which one-half shows the section in solid rock, the other half that with masonry lining. The second tunnel is 2,706 ft. long, and is in loose rock, requiring masonry throughout. Sections of this tunnel are shown in fig. 5, where one-half is the ordinary section, the other half showing the section in more compact rock, and also one of the niches provided for trackmen.

As might be expected from the nature of the road and the country, there are many culverts and bridges. The most striking of these, which is shown in fig. 6, is a bridge crossing the gorge of the Anel River; at this point, which is on one of the rack-rail sections, the road has a grade of 6.8 per cent. The span of the central arch is 184 ft.; the short spans are 53 ft. each, the total length of the bridge being 356 ft. In the cut the river is shown at its ordinary level; in time of flood it fills the entire gorge.




Two classes of locomotives are in use on the road. The first, which is employed on the ordinary sections, has outside cylinders, side tanks, four driving-wheels coupled, and a two-wheeled Bissell truck forward. The cylinders are 11.8 × 17.7 in., the drivers are 39 in. in diameter and the truck wheels 25.5 in. The weight of this engine in working order is 43,000 lbs., of which 33,100 lbs. are carried on the drivers and 9,900 lbs. on the truck. In fig. 7 an outline sketch of this engine is shown.

The second type of locomotive is shown in outline in fig. 8, and is used on the mixed adhesion and rack-rail sections. It is carried on six wheels, four coupled as drivers, these being 39 in. in diameter, and a pair of trailing-wheels under the rear end 25.5 in. in diameter, and working in radial axle-boxes. The cylinders are 13.4 × 19.7 in. The connecting rods work an intermediate axle or shaft, *a*, carried in bearings on the frames; this works the shaft *b* by means of geared wheels, and the adhesion drivers *c* and *d* are coupled by parallel rods to outside cranks on the shaft *b*. The toothed wheel which works on the rack-rail is carried on the shaft *b* under the boiler. This arrangement was adopted as being less complicated than the use of separate cylinders for the rack-rail driver. The engine has driver-brakes and also a special brake for use on the rack-rail. As the

heavy grades are all in one direction the locomotive is placed in the rear of the train going up and in front when descending. The total weight of this type of engine, in working order, is 57,850 lbs., of which 15,550 lbs. are carried on the trailing-wheels and 32,300 lbs. on the drivers.

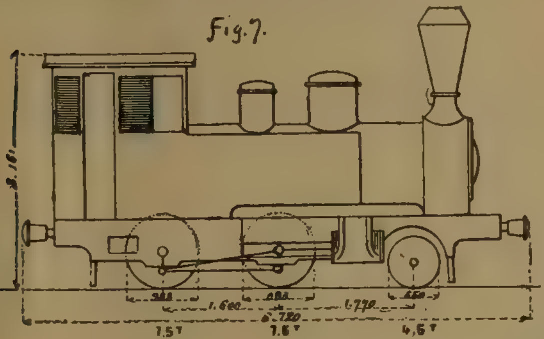


Fig. 7.

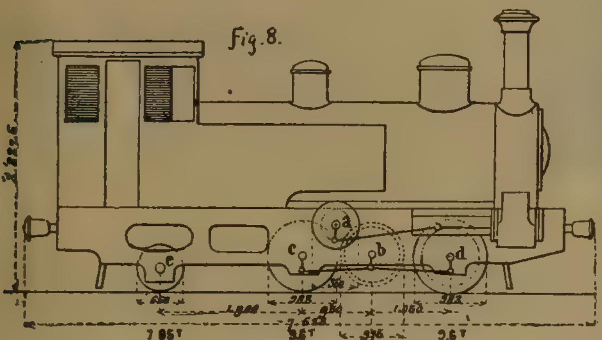


Fig. 8.

The iron-work of the cars was sent from Europe, and the wood-work was done in Sumatra, the timber chiefly used being a native wood called *djatti*. The passenger cars are of the American type, carried on two four-wheel trucks. They are made as open as possible on account of the climate. These cars, which are shown in fig. 9, are 41 ft. long over all, and weigh 25,125 lbs.; the wheels are 31.8 in. in diameter. The roof is of corrugated galvanized iron, and is double, with a space for circulation of air between the outer and inner skins. There are first and second-class cars, which differ only in the arrangement and

Fig. 9. Section.

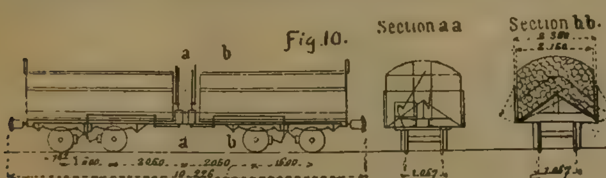


Fig. 10. Section a a. Section b b.

finish of the seats, the car bodies being the same. The first-class will seat 48 and the second-class 64 persons.

The freight cars are of three classes, closed or box cars, coal cars and flat cars; they are all the same as to the platform and running gear. They are 33.5 ft. long over all, 7.7 ft. wide, and are carried on two four-wheeled trucks, the wheels being 30 in. in diameter. The box cars, of which only a few are used, have corrugated iron roofs. The coal cars are the most numerous, and are shown in fig. 10. They carry two boxes or bins of iron on the platform, with a space between them, and are arranged to dump at either or both sides, as indicated in the sketch. These cars weigh 20,400 lbs. empty, and will carry 44,000 lbs. of coal.

In building the road native and Chinese labor was chiefly employed. The Chinaman is the same in Sumatra as he is everywhere else; he is there in large numbers, and is an important element in the industrial life of the island. Much of the unskilled labor was done by native convicts. The Malays of Sumatra are not an industrious people, but experience has shown that with instruction and under good supervision they do very well as trainmen, trackmen and in other subordinate positions in operating the road.

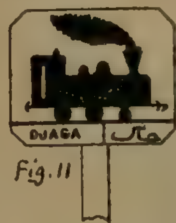



Fig. 11

When the line was first opened, a certain suspicious fear of the *carreta api*—the fire-wagon—prevailed among the natives. This has disappeared, however, and they now travel on the road in large numbers. The Malays are a lively people, fond of change and travel, and the second-class fares are very low.

The stations are generally simple in construction, and are of brick or stone, as wood decays very fast. Coal shipping platforms are provided at Lounto; but the most important works of this class are the shipping piers at Port Emma, where there are excellent arrangements for the quick transfer of coal and freight from the cars to ships. At these wharves there are 34 ft. of water at low tide.

As a curiosity, there is given, in fig. 11, an engraving of one of the signs set up to warn travelers at road crossings; the word *djaga* means simply "look out." It may be mentioned, also, that the time-tables and other notices at stations are printed in four languages—Dutch, Malay, Javanese and Chinese. A telegraph line extends along the whole length of the road, and the trains are run on a system very like the American train-dispatching plan.

Plans are in preparation for several extensions of the Sumatran railroad system, and work on some of the new lines will be begun before long.

## Foreign Naval Notes.

On July 6 the twin-screw armored vessel *Sicilia* was launched from the Government shipbuilding yard at Venice, in the presence of the King and Queen of Italy. This is the tenth ironclad of the first class belonging to the Italian fleet, and was built on the same plans as the *Umberto I.* and the *Sardegna*, being designed by Mr. B. Brin, the late Minister of the Navy Department. The *Sicilia* was commenced November 3, 1884, and the total cost has been estimated at about $5,270,000. Her displacement is 13,250 tons; length, 400 ft.; breadth, 76 ft. 9 in., with a draft of water 28 ft. 9 in. aft and 28 ft. 3 in. forward. The hull of the vessel is made of steel. The engines have been constructed by Messrs. Gio. Ansaldo & Company, of Sampierdarena, and will develop 19,500 H.P. The vessel is expected to attain a speed of 18 knots per hour. The armament will consist of four 12.87-in., 67-ton guns; eight 6-in. guns; six 4.72-in. guns; ten 2.24-in. and seventeen 1.46-in. rapid-fire guns; five torpedo-tubes. The *Sicilia* is one of the heavy armored ships of the Italian Navy which have been severely criticised abroad.

The new British cruiser *Melampus*, during her four hours steam trial, attained an average speed of 18.35 knots an hour, under forced draft. On an eight hours' trial, with natural draft, the engines developed a total of 7,600 H. P., being in excess of contract requirements.

The second-class protected cruiser *Intrepid*, for the British navy, has been launched from the yards of the Glasgow Engineering & Iron Ship-building Company. The *Intrepid* is a sister ship to the *Indefatigable* and *Iphigenia*. She is 300 ft. long, and has 43 ft. 8 in. beam. Her displacement is 3,000 tons. Her speed is estimated at 20 knots an hour. She is propelled by two sets of triple-expansion engines of 9,000 collective H. P. Steam will be supplied by five boilers working at 155 lbs. steam pressure. The cylinders measure 32½, 49 and 74 in. in diameter. The *Intrepid's* battery consists of two 6-in. rifles, six 4.7-in. rapid-fire guns in central pivot mount, eight 6-pdr. Hotchkiss, one 9-pdr. field gun, one 3-pdr. Hotchkiss, four 4.5-in. five-barreled Nordenfelt guns, and four 14-in. Whitehead torpedoes. The 4.7-in. guns are to be placed on the broadside upper deck. The complement of the *Intrepid* is 252 officers and men.

An eminently successful trial of a Thornycroft torpedo-boat, built for the Brazilian Government, is reported from England.

The new boat is 150 ft. long and 14 ft. 6 in. beam. The trial consisted of two parts—first, a series of six runs on the measured mile, with a load of nineteen tons on board, during which a speed of 25 knots was guaranteed by the builders, and, secondly, a continuous run of two hours' duration, during which a

CHILEAN CRUISER "PRESIDENTE ERRAZURIZ."

speed of 24 knots was guaranteed. The mean speed obtained in six runs was 25.858 knots. Messrs. Thornycroft thus more than fulfilling the contract. In the subsequent two hours' trial the vessel averaged 25.387 knots, which is claimed to be the highest speed hitherto maintained by a torpedo boat for that length of time. The armament of the new boat is somewhat peculiar, there being four torpedo guns suited for the 14-in. Whitehead torpedo, instead of three suited for the 18-in. torpedo, as in the Argentine boats. Two of these torpedo-tubes are mounted on racers on deck, and two under deck in the bows, arranged not in the ordinary way, but with gear, enabling them to be protruded through doors in the skin of the boat. These doors, when closed, form a continuous surface with the skin of the vessel, thus presenting no obstruction to the seas, and lessening the broken water and spray which is so easily illuminated by the electric light. When the torpedo guns are run out the torpedo is guided beyond the line of the stem, thus obviating the risk of deflection arising from the pressure of the issuing gases between the torpedo and the skin of the ship. In addition to this armament the little vessel carries two 3 pdr. quick-firing Nordenfelt guns mounted on recoil carriages. The machinery consists of two sets of triple-expansion engines, supplied with steam by two Thornycroft boilers.

THE Russian Navy is being increased with remarkable rapidity, not only in the Baltic, but also in the Black Sea. At the present moment all the shipbuilding yards in Russia are engaged in the construction of iron-clads and monitors. At the Baltic Works the immense cruiser *Rurik*, of 10,000 tons displacement, and capable of steaming 20 knots an hour, is being built, and at the Franco-Russian Works an iron-clad, the *Navarino*, of 9,476 tons displacement, is on the stocks. Another iron-clad is being built at the new Admiralty Wharf in St. Petersburg. At the Nevsky Works an iron corvette and a large ice-breaker are on the stocks, while at the Pvotieloff Works two sea-going monitors are under construction. In all, the Russian Government has 22 ships of war in course of construction, and many more orders have been given.

### FRENCH TORPEDO BOATS.

IN last year's naval maneuvers so much trouble was experienced with the torpedo boats in the French navy that it was resolved to reconstruct those of the 35-meter class so as to give them additional stability. The want of stability was found to result chiefly from the cross-section adopted for these boats, with sharply re-entering sides nearly flat. To remedy this the form has been entirely changed for over one-third of the length of the boat. The accompanying cut, from *Le Yacht*, shows one of these boats as altered, and in fig. 2 is a cross-section, the dotted line *A* showing the original form, and the full line *b* that now

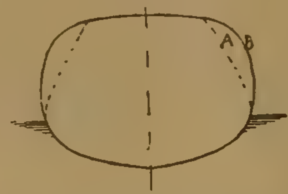



Fig. 2.

adopted. The forward lines have also been changed to give the boats better protection against a rough sea. The armament has also been changed; formerly these boats carried two torpedo-tubes forward, but now they have only one forward, the second one having been mounted on a pivot aft of the smoke-stack. It is believed that these changes will make them much more seaworthy and useful boats.

### THE "PRESIDENTE ERRAZURIZ."

THE accompanying illustration shows the new protected cruiser, *Presidente Errazuriz*, lately completed by the Société des Forges et Chantiers de la Mediterranée, at Toulon, France; this cruiser and its sister ship, the *Presidente Pinto*, attracted much attention, on account of the uncertainty as to their ownership previous to the success of the late revolution in Chili.

FRENCH TORPEDO BOAT, 35-METER CLASS.

The *Presidente Errazuriz* was ordered by the Chilian Government in 1888, and is a protected cruiser 268 ft. in length, 36 ft. beam and 2,080 tons displacement. She has a protective deck varying in thickness from 1.5 to 2.4 in., and extending 28 in. below the water-line. The engines have worked up to 5,400 H.P., and the ship has shown on trial a speed of 15 knots with natural draft and 19 knots with forced draft. The coal bunkers

will hold coal enough to give her a cruising radius of 4,500 knots at a 12-knot, or 2,550 at 15-knot speed.

The main battery consists of four 15-cm. (5.9-in.) and two 12-cm. (4.7-in.) Canet guns. The secondary battery includes four 47-mm. (1.85-in.) and four 37-mm. (1.46-in.) revolving cannon and one Nordenfelt machine gun; there are also three torpedo-tubes.

### AN ENGLISH PNEUMATIC GUN.

A new torpedo gun has been invented by J. E. Bott, an engineer of Manchester, England, and is shortly to be tried. The descriptions so far given are not very definite, but from them it would seem to differ from the Zalinski gun in having no machinery for compressing air attached to the gun itself, and in giving a sudden impulse to the projectile, instead of a continued pressure. A breech-loading smooth-bore gun is used, and it is calculated that shells can be thrown three miles. Any smooth-bore cannon of large caliber can be used, with some slight changes in the breech. The shell itself is divided into two chambers, the forward one, about one-fourth of the whole length, containing the charge of dynamite or other high explosive, provided with the usual fuse or detonator. The rear chamber, occupying about three-fourths of the shell, is filled with compressed air at a very high pressure. When the shell is placed in the gun, a pin in the breech is operated so as to force back or cut away aretaining valve or plug in the rear end of the shell, and the compressed air thus suddenly released impinges on the breech of the gun, giving the shell its forward impulse.

## THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

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(*Continued from page* 473.)

(Correction.—Through an error of the printer, the numbers of figs. 334 and 335, in the article on The Essentials of Mechanical Drawing, published last month, were transposed—that is, fig. 334 should be 335 and 335 should be 334.)

### CHAPTER XIII.—(*Continued.*)

### INVOLUTE TEETH.

It remains to explain how to find the diameters of the base circles of wheels with involute teeth. From fig. 340 it is obvious that the teeth of the wheel and pinion are in contact with each other on the line $v\ P\ w$, which is therefore called their *line of action*, which is tangent to the base circles $r\ d'\ t$ and $R\ d\ T$. If, now, from the tangent points $v$ and $w$ of the line $v\ P\ w$ with the base circles we draw radii $v\ b$ and $w\ D$, to the center of the pinion and wheel; we will have two similar triangles, $b\ v\ P$ and $D\ w\ P$, so that, by a well-known principle of geometry, their sides will be proportional—that is, $D\ w$, the radius of the base circle of the wheel, will bear the same proportion to $b\ v$, the radius of the base circle of the pinion, that $D\ P$, the radius of the pitch circle of the wheel, bears to $b\ P$. the radius of the pitch circle of the pinion. Therefore the base circles bear the same proportion to each other that the pitch circles do, which is one of the conditions which they must fulfil. It can be proved by the same demonstration that if we draw a line of action, $v\ P\ w$, at any angle to the center-line $b\ P\ D$ and draw base circles tangent to this line, that they will bear the same proportion to each that the pitch circles do. Therefore the line of action may have any angle to the center-line. It remains to show what angle is preferable.

Suppose that the pinion in fig. 341 has 12 teeth, which is the smallest number that will work satisfactorily with involute teeth; and that the pinion gears into a larger wheel, and that $h\ v$ is the outline of a tooth of the pinion and $v\ o$ that of a tooth of the wheel, $E\ F\ G$ and $e\ f\ g$ being the addendum circles. It is plain that the tooth $h\ v$ of the pinion cannot come in contact with $v\ o$ of the wheel until the outline of $h\ v$ intersects the addendum circle $E\ F\ G$ at $v$. Consequently, in order that the teeth may have as long a line of action as possible, it should be drawn through $v$ and $P$, the pitch-point, which determines the angle of the line of action with the center-line $b\ P\ D$; but if the diameter of the wheel was increased the point of intersection, $v$, would be moved toward $n$. If the radius of the wheel was infinitely long, the pitch circle $A\ P\ C$ and the addendum circle $E\ F\ G$ would become straight lines. In order that gear wheels may be interchangeable, it is desirable that the smallest practicable pinion may gear into a wheel with the longest radius, which would be a straight rack, whose radius is of infinite length. Therefore, lay off from $P$, the depth $P\ F$ of the addendum of the tooth of the wheel, from the pitch-line and draw a straight line, $S\ F\ s$, through $F$ and perpendicular to $b\ P\ D$, the center-line.

It has been explained that if a radius, $b\ v$, fig. 340, be drawn through $b$, the center of the pinion, and $v$, the tangent point of the line of action $v\ P$ with the base circle, that we will have a right-angled triangle $b\ v\ P$. If, now, on the radius $b\ P$, fig. 341, as a diameter, a semi-circle, $b\ k\ P$, is drawn, intersecting $S\ f\ s$ at $n$, and a line, $b\ n$, is drawn through the center $b$ and $n$, and another line, $n\ P$, be drawn through $n$ and the pitch-point $P$, then the triangle $b\ n\ P$ being inscribed in a semicircle will have a right angle at $n$, and if a base circle, $r\ n\ a'\ t$, be drawn from the center $b$ with the radius $b\ n$, it will fulfill all the required conditions—that is, a tooth of the pinion would first come in contact with a tooth on the rack at $n$, so that $n\ P$ would give the longest possible line of action, and $n\ P$ will be tangent to the circle drawn through $n$, and will pass through $P$, the pitch-point. If the pinion gears into a wheel, $n\ P$ should

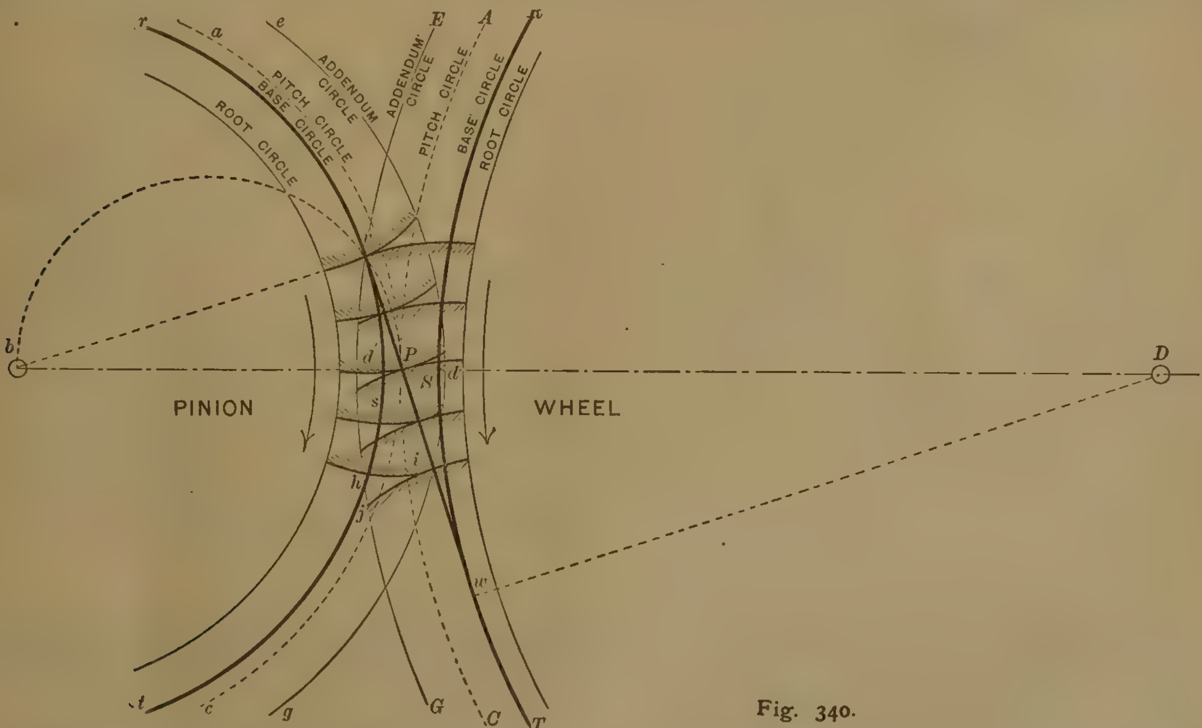



Fig. 340.

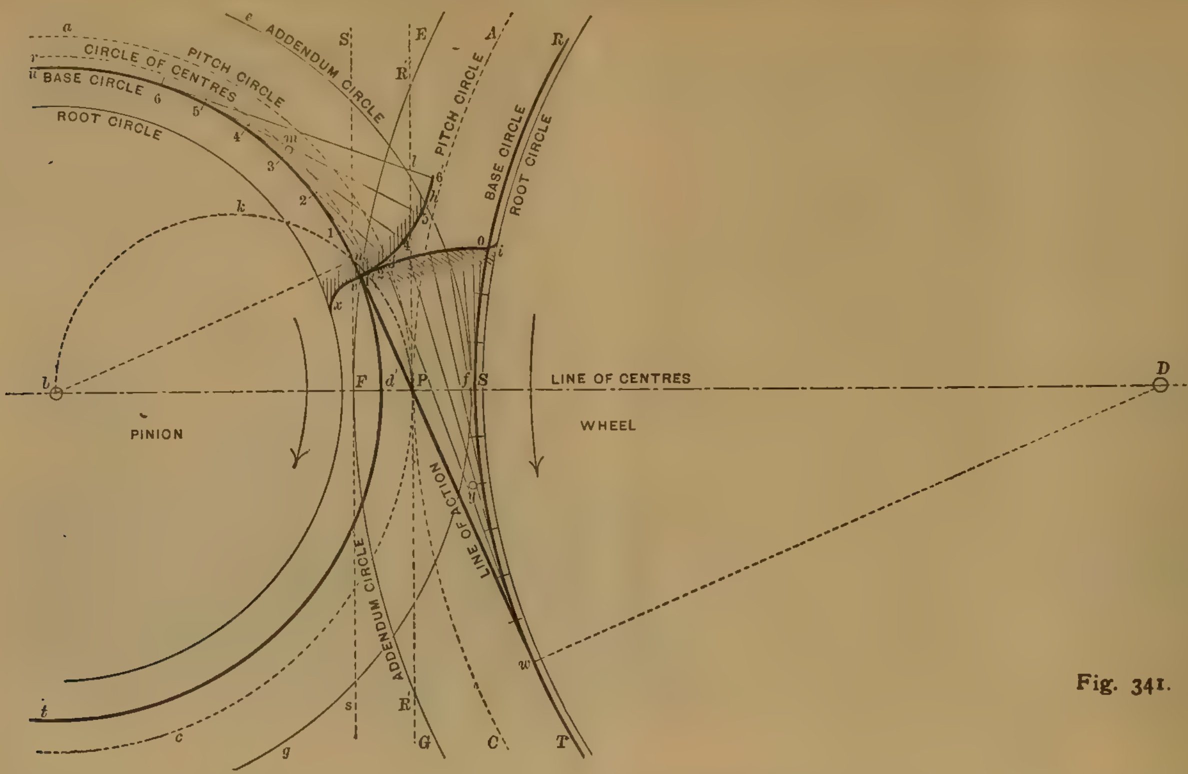



Fig. 341.

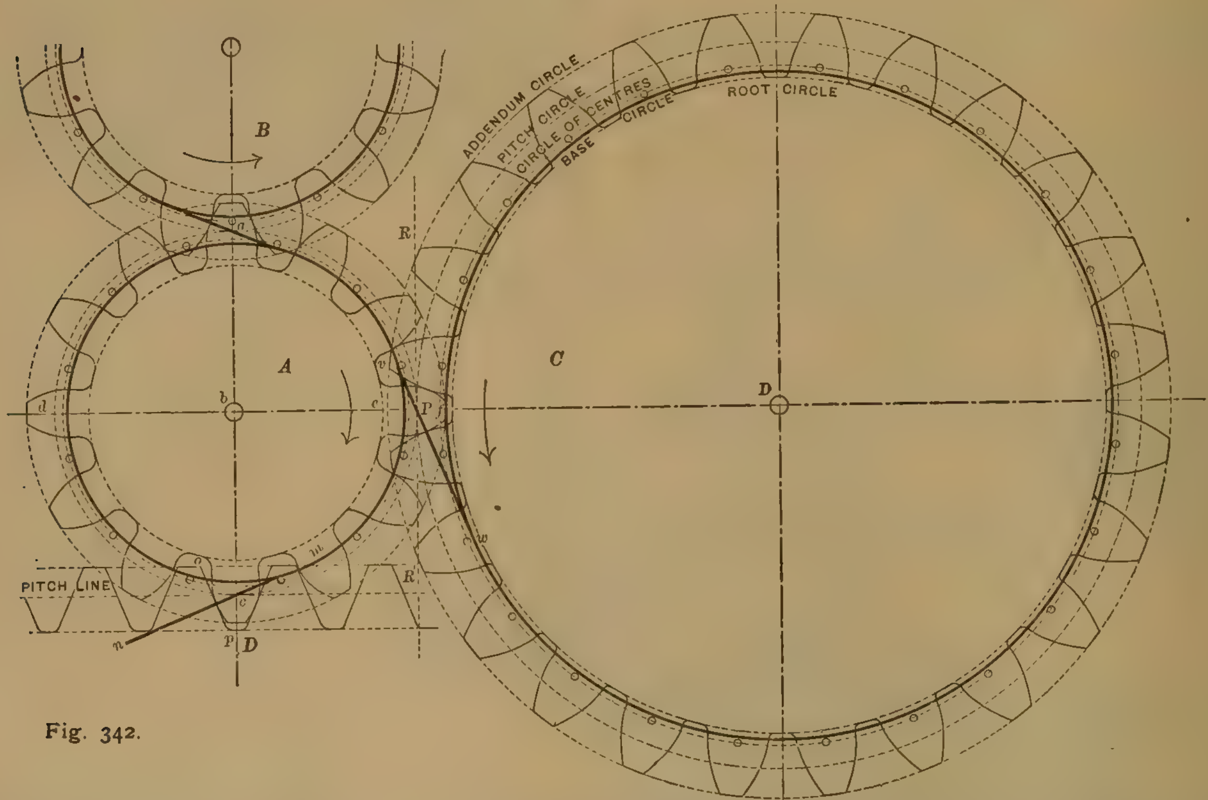



Fig. 342.

be extended toward $T$, and a circle, $R\ S\ T$, drawn from the center $D$ of the wheel and tangent to $n\ P\ T$. The circle thus drawn will be the base circle of the wheel.

In the case of a pinion of 12 teeth gearing into a rack, the angle of $n\ P$—the line of action—with $l\ P\ G$—a line drawn through $P$ and perpendicular to $b\ P\ D$, the line of centers—is equal to 23° 21′, but which may be taken at 23°. As this angle can be used for all wheels and pinions, and gives the longest line of action in all cases, it has been proposed as a standard for gear wheels.

If this angle is adopted, the most convenient way of laying out the base circles is by simply drawing the line of action through the pitch-point $P$ at an angle of 23°, to a line, $l\ P\ G$, tangent to the pitch circle at that point, or at an angle of 67° to a radius, $b\ P$ or $D\ P$, drawn through the pitch-point and then draw the base circles tangent to this line of action.

## TO DRAW INVOLUTE TEETH FOR A WHEEL, PINION AND RACK.

The proportions for the teeth of wheels, which were given last month, were for rough-cast teeth. As then stated, when such teeth are used, considerable clearance is needed between them, and at their roots, owing to the roughness and irregularities of the castings. When teeth are cut in a machine, and are thus of a more exact form, less clearance is required, and they

may be made of the same thickness, or very nearly so, as the spaces between them, and only about half as much room need be allowed between the tips of the teeth of one wheel and the bottom of the spaces. The following are good proportions for teeth which are "cut" or finished on a machine :

PROPORTIONS FOR CUT TEETH OF GEAR WHEELS.

$P$ = Pitch which is divided into 16 parts.
$T$ = Thickness of tooth measured on pitch circle = 8 parts.
$S$ = Space between teeth measured on pitch circle = 8 parts.
$d$ = Depth from pitch circle to tip of tooth = 5 parts.
$D$ = Depth from pitch circle to base of tooth = 6 parts.
$D + d$ = Whole depth of tooth = 11 parts.
$R$ = Thickness of rim and arms of wheel = 9 parts.
$L$ = Length of tooth measured parallel to axis of wheel = 2 or 3 times the pitch or 3 $P$.

To illustrate how the teeth of different wheels are laid out, a pinion, $A$, with 12 teeth has been represented in fig. 342,* geared

subdivided into the required number of divisions in one operation.

Having divided the pitch circle the width of the teeth = one-half the pitch should then be laid off on the pitch circle. The depth $P\ f$ from pitch circle to the tip of the teeth and the depth $P\ e$ from pitch circle to the base or root of teeth should then be laid off, and the addendum and root circles drawn through these points. Then through the pitch-point $P$ draw the line of action $v\ P$ at an angle o 23° to a line, $R\ R'$, perpendicular to the line of centers $b\ P\ D$, and from the center $b$ of the pinion draw a circle tangent to $v\ P$. This will be the base circle of the pinion from which the involute curve, which forms the outline of the teeth, must be drawn. The method of doing this was explained in Problem 97, of Chapter XI., but a little further explanation may make the method of doing it clearer.

Referring to fig. 341, let it be supposed that the outline of a tooth is to be drawn through the point $v$. First lay off from $v$, on the base circle $u\ v\ d'$, a number of equal spaces, 1, 2, 3, etc.

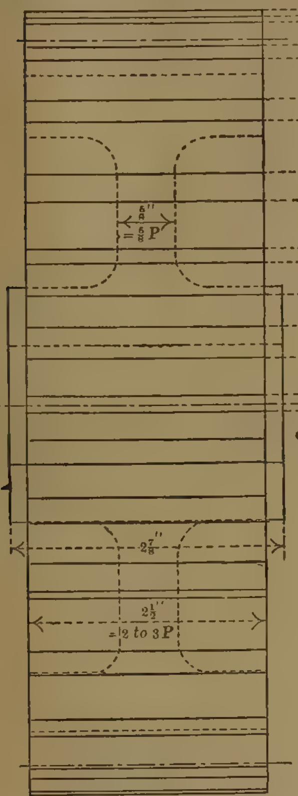


Fig. 344.

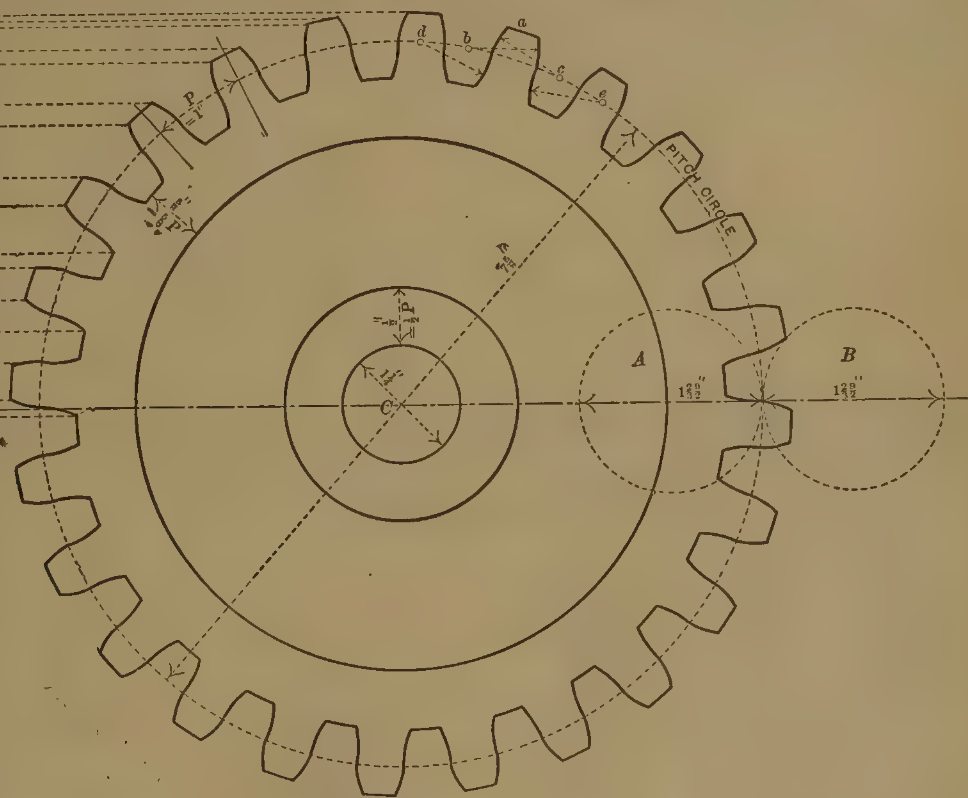



Fig. 343.

nto another pinion, $B$, of the same size—only half of which is shown—and into a wheel, $C$, with 24 teeth, and also into a rack, $D$. The drawing is supposed to be drawn to a scale of 3 in. = 1 ft., or one-quarter size the pitch of the teeth being 2 in. The learner should draw this full size.

It has been explained that the *pitch*—that is, the distance from the center of one tooth to the center of the next one, is measured on the pitch circle, and is an arc, and not a chord of the circle. Consequently, if we multiply the pitch by the number of teeth in a wheel or pinion, will give the length of the circumference of the pitch circle, and dividing by 3.1416 will give its diameter. In the example under consideration the pinion $A$ has 12 teeth of 2 in. pitch, so that $2 \times 12 = 24$ in. = circumference of pitch circle, $\frac{24}{3.1416} = 7.67$ in. = diameter of pitch circle $a\ P\ c\ d$ which is drawn of that diameter = $7\frac{11}{16}''$ full. With a pair of dividers this circle is divided into 12 equal parts. In doing this, especially if a wheel has many teeth, it will be found advisable to first divide the circle into parts containing some multiple of the whole number of teeth, if that is possible. Thus, in the present instance, the pinion has 12 teeth, so that the pitch circle may be first divided into four equal parts, and these can then be subdivided into three parts. By adopting this method the division can be made more quickly and with greater accuracy than is possible if the pitch circle is

* This diagram is an imitation of one in Thorne's book on Mechanical Drawing.

Through these points draw lines tangent to the base circle. With the same space between the points of dividers step off, from each of the points, 1, 2, 3, etc., on the tangents drawn through these points, the same number of divisions as each point of tangency is from the point of origin $v$, and mark the final points of division at 1', 2', 3', 6', etc. Then draw a curve, $h\ v$, through the points 1', 2', 3', etc., which will be the required involute and the outline of the face of the tooth.*

Having laid out the outline of the tooth, find with a pair of compasses a center, $m$, of an arc which will coincide most closely with the involute. Then from the center of the wheel draw a circle called a *circle of centers* (indicated by a dotted line in the engraving) through this point, on which all the centers of the tooth-arcs will be located.

The method of drawing the outline $v\ o$ of the wheel will be sufficiently plain from the preceding description, and from the construction lines in the drawing. The outlines of the opposite sides of the teeth are, of course, drawn with the same radius. If the thickness of the teeth is set off on the pitch circle, the radius of the arc, which approximates most closely to the outline of the teeth, and the circle of centers has been laid down, the simple problem then is to draw such arcs through the points laid off on the pitch circle from a center which must be on the circle of centers.

* This method is not absolutely correct, for the reason that the space between the points of the dividers with which the spaces 1, 2, 3, etc., are stepped off is equal to the chord of the arc included, which is somewhat less than the length of the arc itself. If the spaces are short, no appreciable error will result by adopting this method.

The portion of the flank of the tooth lying within the base circle may be a radius to it and tangent to the involute. In order to strengthen the teeth small fillets should be drawn at their roots connecting them with the root-circles. These fillets are arcs of circles, and should be made as large as can be made to clear the engaging teeth.

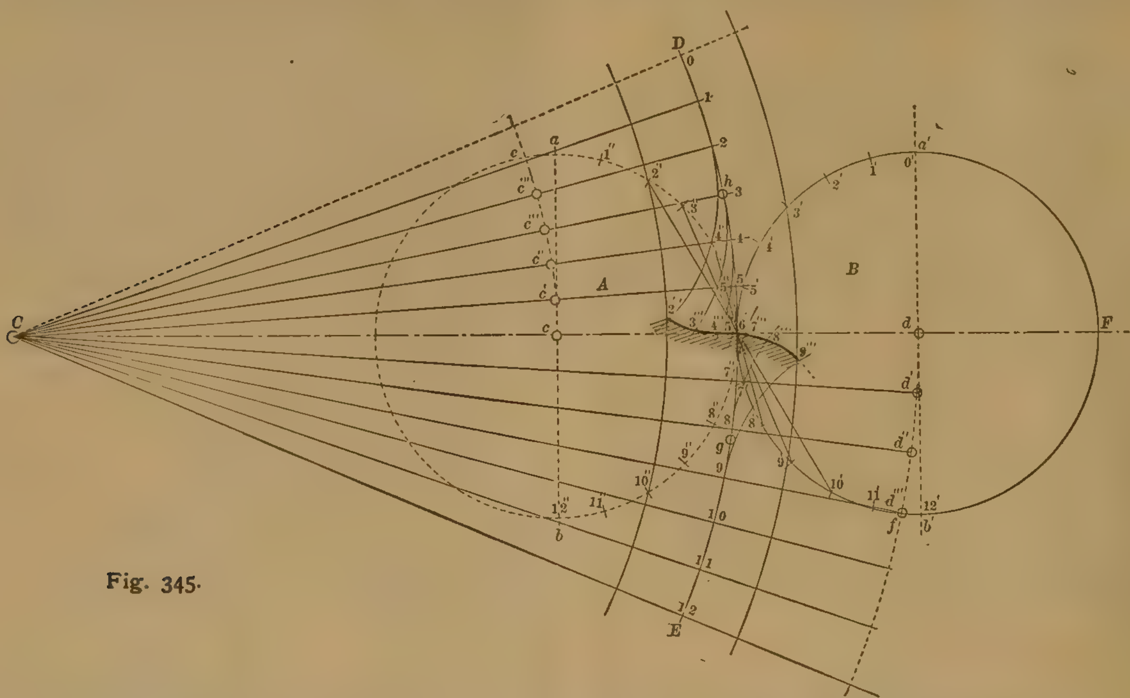


Fig. 345.

### CYCLOIDAL TEETH.

Let it be supposed, now, that a gear wheel with 24 teeth of 1 in. pitch is to be drawn to gear into a pinion with 12 teeth, the latter to be cycloidal in form. Multiplying 24 × 1 and dividing the product by 3.1416 gives the diameter of the pitch circle = $7\frac{5}{8}''$ full. This is drawn from the center *C* in a dotted line, in fig. 343, which is one-half size. The addendum and root-circles are then drawn and the pitch circle is first divided into four equal parts, then into eight, and finally into 24 = the number of teeth. It being supposed that the teeth are to be cut on a machine, their thickness is laid off on the pitch circle = $\frac{1}{2}$ *P*. As the wheel is to gear into a pinion with 12 teeth, which would be one-half the diameter of the wheel, the generating circles *A* and *B* are taken at one-fourth the diameter of the wheel = $1\frac{29}{32}''$. To lay out the form of the teeth an arc, *D E*, of the pitch circle is drawn full size from the center *C*, in fig. 345, and the generating circles *A* and *B* are also drawn on the line of centers *C F* and tangent to the pitch circle at 6. The problem now is to describe an exterior epicycloid on the outside of the pitch circle, which would be generated by a point, 6, on the circle *B* in rolling on the outside of arc *D E*, and also to draw an interior epicycloid which would be generated by a point, 6, in the circle *A* in rolling on the inside of the arc of the pitch circle. The method of drawing such curves was described in Chapter XI., Problem 93, but a little further elucidation of the method of doing it will be given here.

In the first place, ascertain the circumference of the pitch circle, which, in drawing the curves, will be the fundamental circle, and also the circumference of the generating circle, and multiply it by 360° and divide the product by the circumference of the pitch circle. This will give the number of degrees of the angle which will include an arc of the pitch circle of equal

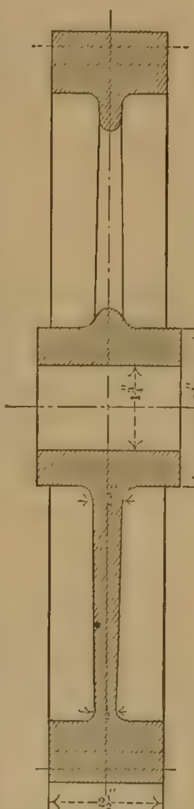


Fig. 347.

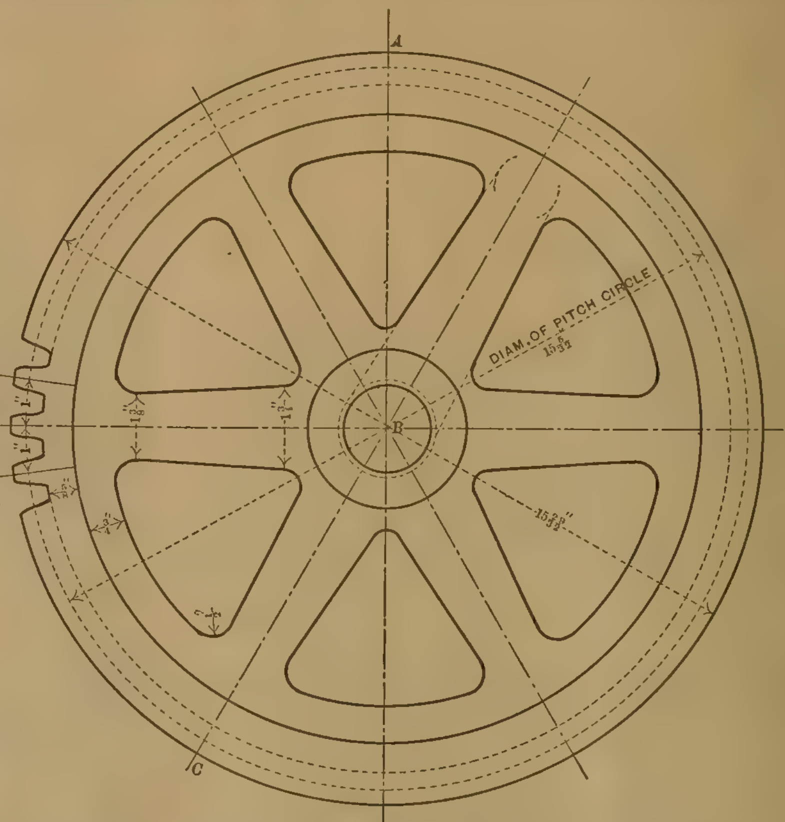



Fig. 346.

length to the circumference of the generating circle. From the center $C$ lay off an angle, $D\,C\,E$, but for convenience make this only half as large as the angle which has been calculated. Then the arc $D\,6\,E$ will be equal in length to one-half the circumference of $A$ and of $B$. Divide the arc $D\,6\,E$ into any even number of equal parts, 0, 1, 2, 3, etc., and the semi-circumferences $a\,6\,b$ and $a'\,6\,b'$ of $A$ and of $B$ into the same number of equal parts, letting points of division coincide at 6. Through the center $C$ of the pitch circle $D\,6\,E$ and the points of division 0, 1, 2, 3, etc., of that circle, draw radii $C\,0$, $C\,1$, $C\,2$, etc. From $C$ as a center draw arcs $e\,c$ and $d\,f$ through the centers $c$ and $d$, and extend the radii $C\,7$, $C\,8$, $C\,9$, etc., to intersect $d\,f$ at $d'$, $d''$, $d'''$, etc. From 6 draw chords, 6 2'', 6 3'', 6 4'', 6 5'', 6 7', 6 8', 6 9', 6 10', to the points of division of the generating circles. Then from the centers $d'$, $d''$, and $d'''$, with the radius of the generating circles, draw arcs 7 7''', 8 8''', 9 9''' tangent to the pitch circle. Take with a pair of dividers the length of the chord 6 7', and set this distance off on the arc from 7 to 7''' and mark the point 7'''. In the same way take the length of the chord 6 8' and set it off on the arc from 8 to 8''', and also the chord 6 9' on the arc 9 9'''. Then a curve drawn through the points 6, 7''', 8''', 9''' will be the outline of the face of a tooth. From the points of intersection $c'$, $c''$, $c'''$, $c''''$ of the radii with the arc $e\,c$, as centers, draw other arcs, 2 2''', 3 3''', 4 4''', 5 5''', and set off on them from 2, 3, 4, and 5, in the same way as has been explained, the length of the chords 6 2'', 6 3'', 6 4'', and 6 5'', then a curve drawn through the points 2''', 3''', 4''', 5''', 6 will form the outline of the flank of the tooth. Having laid down these curves, find centers $g$ and $h$, from which arcs may be drawn, which will approximate as closely as possible to these curves. In the present example these centers are both on the pitch circle. If they should be without or within it, their position should be laid down on the drawing and circles of centers drawn through them, on which all the centers of the arcs which form the outlines of the teeth would be located. Having the radii of the arcs which approximate to the outlines of the teeth, and the circles of centers and the thickness of the teeth being laid down, they are then readily drawn. Their correct outline may also be laid out by the mechanical method described in the article published last month, and illustrated by fig. 339. A fillet, 2''', fig. 345, should also be drawn at the roots of the teeth to strengthen them at that point.

The usual method in drawing gear wheels with cycloidal teeth is to take the centers of the arcs for the faces of the teeth on the pitch circle, in the middle of the adjoining spaces between the teeth, and that for the flank of the teeth also on the pitch circle in the middle of the adjoining teeth. This method has been adopted in drawing fig. 343, the centers of the faces of tooth $a$ being taken on the pitch circle at $b$ and $c$ in the middle of the adjoining spaces, and the centers of the flanks are taken at $d$ and $e$, in the middle of the next teeth. When this is done, it must be left to the pattern-maker or machinist to lay out the exact form of the teeth. It is well in all cases where a correct form is desired to give a separate drawing, similar to fig. 345 or fig. 339, showing the method and the exact dimension to be used in laying out the teeth.

In making small gear wheels, it is customary to make the center or the part between the hub and the rim of the form of a plate or disk, as shown in fig. 343. Larger wheels have spokes. The following are good proportions for different parts of gear wheels:

Thickness of rim below the bottom of teeth = $\frac{5}{8}$ pitch.

Thickness of plate between hub and rim of plate wheels = $\frac{5}{8}$ pitch.

Depth of web below rim of a wheel witharms = $\frac{3}{4}$ pitch.

Width of arms at the web for wheels with, say, less than 50 teeth = $1\frac{5}{8}$ pitch.

Width of arms at the web for wheels with, say, over 50 teeth = $1\frac{3}{4}$ pitch.

Width of arms to be tapered from $\frac{11}{16}$ in. to $\frac{3}{4}$ in. per foot of length.

Thickness of arms $\frac{5}{8}$ of their width.

Thickness of web inside of rim is the same as that of the arms which join it.

Diameter of hub $1\frac{3}{4}$ to 2 times the diameter of shaft.

Length of hub not less than $1\frac{1}{2}$ times the diameter of the shaft.

In making working drawings it is a very common practice to draw only the outside or addendum circle and the pitch circle, and show only a few of the teeth, as represented in fig. 346. This shows a gear wheel with 48 teeth of 1 in. pitch engraved to a scale of 3 in. = 1 ft. The student should draw it full size. What has been said of the proportions of the spokes, rim, etc., and the explanation of the method of drawing pulleys, in Chapter VI., makes any further directions for drawing these parts of a wheel unnecessary. It is customary to show one view of such wheels in section, fig. 347, as in this way the proportions of the hub, arms, rim, etc., can be shown more clearly than by an external view. The section is supposed to be on the line $A\,B\,C$, so that in the top portion the shape of the rim is represented and in the lower part that of one of the arms. The sections of the arms are supposed to be elliptical in shape, but such arms are sometimes made of cruciform, T or I shape, although this practice has now to a great extent gone out of fashion.

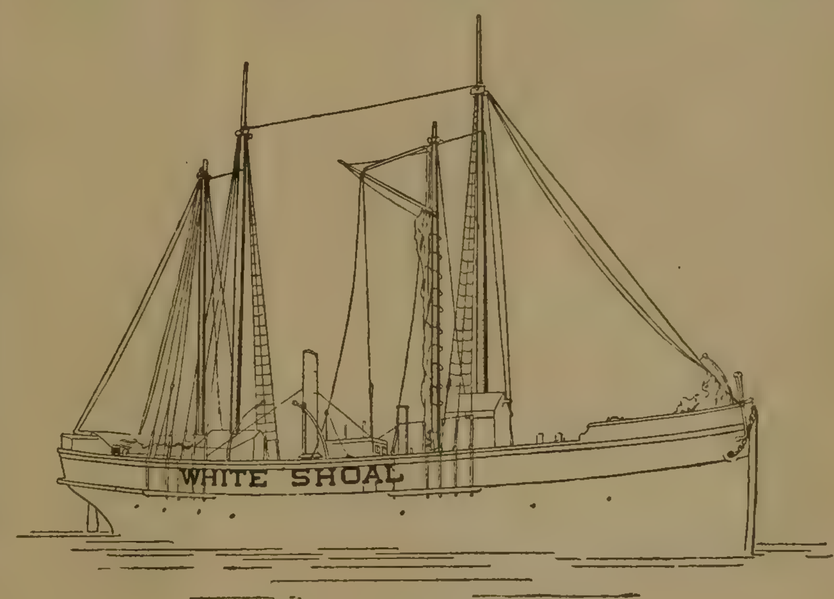
The number of arms in wheels is fixed very arbitrarily. Unwin, in his "Elements of Machine Design," makes the general observation that "usually there are four arms for wheels not exceeding 4 ft. in diameter; six arms for wheels of from 4 ft. to 8 ft.; and eight arms for wheels from 8 ft. to 16 ft. diameter."

(TO BE CONTINUED.)

## Lightships for Lake Stations.

(From the Cleveland *Marine Record*.)

THE accompanying cut shows the type of three lightships built for service and now ready for placing on White Shoal, Simmon's Reef and Gray's Reef, Lake Michigan. Eleven lake shipbuilding firms made bids for their construction last March, and the contract was duly awarded to the lowest, the Craig Shipbuilding Company, Toledo, O., who have completed their work under a Government superintendent of construction




LIGHTSHIP FOR LAKE MICHIGAN.

according to the specifications of the Lighthouse Board. These vessels are notable on account of being the only lightships under Government jurisdiction now afloat on the lakes, and they mark an era in the systematic lighting of channels, fairways and dangers which has long been sought by the lighthouse officials in charge of the lake districts, the vessel owners and kindred interests. Their dimensions are 100 ft. over all, 21 ft. beam, and 14 ft. deep (molded). Engines, cylinders 14 × 15 in., speed about 6 miles per hour.

The cost of construction for the three lightships was $44,429, or nearly $14,810 each, including windlasses, fog whistles, trysail masts and extras.

# Manufactures.

### General Notes.

THE office of the Lappin Brake Shoe Company has been removed to Room 406, Welles Building, No. 18 Broadway, New York.

THE Cooke Locomotive Works, Paterson, N. J., are building 25 engines for the Chicago, St. Paul & Kansas City Railroad.

THE largest fly-wheel in the country, it is claimed, is in the new power-house of the West End Street Railroad, in Boston. The wheel is 28 ft. in drameter, 10 ft. 7 in. face, and weighs 80 tons. It carries two 54-in. belts, and the velocity of the rim is 6000 ft. per minute.

THE American Steel Wheel Company has decided to remove its plant from Boston, and to put up extensive buildings at a point where materials and fuel can be had at lower cost for freight. A point on the line of the Central Railroad of New Jersey, some 20 or 25 miles from New York, will probably be selected.

RECENT orders for locomotives include one for 35 given to the Brooks Locomotive Works by the Lake Shore & Michigan Southern Company. The Boston & Albany has placed an order for 25 engines with the Rhode Island Locomotive Works in Providence.

THE St. Charles Car Company has an order for 300 coal cars of 60,000 lbs. capacity for the Texas & Pacific. This company has also an order for two first-class chair cars for the Toledo, St. Louis & Kansas City road. They will be mahogany finish, with spacious smoking room and complete buffet, and will be very handsome cars.

THE Grant Machine Tool Works has recently established at Fitchburg, Mass., works for making by new process anti-friction steel balls, ball bearings, and specialties of steel. They will also make the standard brake-pin. Mr. R. H. Grant is Superintendent, and John J. Grant, formerly of the Simonds Rolling Machine Company, is General Manager.

FEW roads in the Central States have made greater improvements recently than the Toledo, St. Louis & Kansas City, under the presidency of S. R. Callaway. A large quantity of new steel has been put down, the track ballasted, and other improvements made. The company has just received 500 new box-cars and is having 10 new locomotives built. Several new chair cars have also been ordered, and the company will continue the work until the line is completely equipped.

THE Brooks Locomotive Works, Dunkirk, N. Y., have recently completed a compound locomotive for the Lake Shore & Michigan Southern road. It is a 10-wheel freight engine.

THE Bucyrus Steam Shovel & Dredge Company, Bucyrus, O., has completed the machinery for a new dredge boat for the United States Government. The boat is intended for use on the Cumberland and Tennessee rivers, and its first work will be on the Mussel Shoals Canal. The boat is 80 ft. long, 35 ft. beam, 6½ ft. deep. The dredge is of the elevator type, with steel buckets, and is so arranged as to discharge the material into the scows at either side, or over the end at any distance up to 80 ft. The same Company has recently furnished a large dredge to the New Orleans & Northeastern Railroad. It is to be used in filling up the long trestle over Lake Pontchartrain.

THE contract for the iron work of the new elevated line of the Philadelphia & Reading Railroad into Philadelphia has been awarded to A. & P. Roberts, of the Pencoyd Iron Works. It includes the iron work for the elevated line and for the train-shed and market-house at Twelfth and Arch Streets, and is one of the largest contracts in this line ever let.

THE Ship Owners' Dry Dock Company has recently completed a new timber dry-dock at Cleveland, O., which is 336 ft. long on the floors, 45 ft. wide at the bottom and 85 ft. at the top. The gate is 47 ft. wide on the sill, and has a depth of 15 ft. when the dock is full. The pumping machinery consists of two vertical pumps, each with 24-in. discharge, driven by two horizontal engines, with 18 × 20 in. cylinders. These pumps will empty the dock in 45 minutes.

THE *Marine Review* reports about 40,000 tons now under construction in the Lake ship-yards. This includes two wooden vessels and one steel one in the Wheeler Yard at West Bay City; a large wooden steamer in the Davidson Yard at West Bay City; two lumber-carrying boats at the Marine City Yard; a steel steamer in the Detroit Dry Dock Company's yard, and eight whalebacks in the yard of the American Steel Barge Company, at West Superior.

THE power station of the East End Electric Light Company, in Pittsburgh, is entirely supplied with the Westinghouse engine. The company has in its plant 15 of these engines, aggregating 1,800 H.P., and including two 18 and 30 × 16 in. compounds; three 11 and 19 × 11-in. compounds; one 18 × 16-in. standard; three 15½ × 14-in. standard; four 12 × 11 standard; one 11 × 10-in.; and one 7½ × 7-in. standard. There are 21 dynamos run by these engines, aggregating 12,000 incandescent and 420 arc lights.

THE New York Central & Hudson River Company has contracted with the Consolidated Car Heating Company, of Albany, N. Y., for the re-equipment of all its cars, the work to be completed within 60 days. The Consolidated direct steam system with the Sewall coupler will be used. The Consolidated Company has also recently received orders for 90 commingler equipments for the Canadian Pacific; 65 for the Boston & Maine; 50 for the Old Colony, and 35 for the Concord & Montreal. The Sewall coupler will be used in all of these.

THE Harlan & Hollingsworth Company, in Wilmington, Del., has lately taken contracts for four steel boats for service on Long Island Sound. These boats are a departure from the side-wheel type in general use on those waters, all having twin screws. Two of them are for the Providence & Stonington Steamship Company; they will be 310 ft. long over all, 302 ft. on the water-line, 44 ft. beam and 60 ft. over the guards. Each will have one triple-expansion engine, with high-pressure cylinder 28 in., intermediate 45 in., and two low-pressure cylinders, each 51 in. in diameter, all being 42 in. stroke. The other two boats, for the New Haven Steamboat Company, will be 315 ft. long over all, 300 ft. on the water-line, 47 ft. 10 in. beam and 53 ft. over the guards. Each will have two triple-expansion engines, with cylinders 24 in., 38 in. and 60 in. in diameter and 30-in. stroke.

THE firm of Watson & Stillman, of New York, have recently added 5,000 ft. to their already large hydraulic machinery works, greatly facilitating the production of railroad tools. The output of hydraulic jacks and car-wheel presses during the last two years has increased to such an extent that the adoption of this course was necessary in order to keep abreast with their orders.

THERE was a slight fire at the Richmond Locomotive Works, Richmond, Va., on the night of October 15, which was fortunately soon discovered, and was quickly extinguished by prompt action. Practically the only damage done was to the roof of the foundry, and full operations were only delayed for a day or two. These works are in a better condition for prompt and satisfactory work than ever before.

THE Riehle Brothers Testing Machine Company, in Philadelphia, has just completed a large vertical screw-power testing machine for the School of Practical Science in Toronto, Ont. This machine is arranged with two movable cross-heads for quick adjustment, for testing long and short specimens for tensile strength. It will test by tensile strains specimens from 10 ft. down to 6 in. long; transverse specimens from 18 ft. to 1 ft.; compression specimens from 12 ft. down.

ON October 1 there was cast at Carnegie, Phipps & Company's Homestead Steel Works a nickel-steel ingot weighing 25 tons, which was without a flaw. It is to be reheated and rolled into a single plate for the United States coast defense vessel *Monterey*, in course of completion. This was the largest nickel-steel ingot yet made in this country, but a few days later the works cast one weighing 50 tons, designed for the same vessel; when finished it will be 13 in. thick.

THE limited trains of the Erlanger system, which run between Cincinnati & Florida, have coaches elegantly furnished and supplied with all modern conveniences, including steam heat and Pintsch gas.

THE equipment of 200 cars for the New York, New Haven & Hartford Railroad with steam heat has been completed by the Safety Car Heating & Lighting Company, of New York. The New York & New England cars are being rapidly fitted with the Gibbs couplers, which are used in connection with the Safety Company's hot water circulating system.

### Baltimore Notes.

WORK upon the tunnel of the Belt Railroad is progressing better than is generally known. Up to this date over 2,000 ft. of the brick work of the total 6,000 ft. have been completed and arched out.

THE directors of the City Passenger Railway Company—which includes the Red, White and Blue Lines—have selected sites for the three power houses of the new cable line, and the board has confirmed the purchase. One house will be located

on South Eutaw Street, between German and Lombard; one at the corner of East Baltimore and Easts street, and one at or near the terminus on West Baltimore Street, above Fulton Avenue.

THE Baltimore & Ohio is building a line that, when completed, will be known as the Metropolitan Southern, and will run from Linden on the Metropolitan Branch, nine miles west of Washington, to a point south 24 miles. It will be a single track road. Mr. W. L. Sission, Assistant Chief Engineer, has charge of the construction.

IT is rumored that after January 1, 1892, the Monongahela River Railroad in West Virginia will be operated by the Baltimore & Ohio Railroad as part of its Wheeling & Parkersburg Division.

THE Mt. Clare shops, Baltimore & Ohio Railroad, have received orders for the construction of seven new 52-ft. baggage cars, 15 new standard caboose cars, and two standard derrick cars.

THE Baltimore & Ohio has about completed at Benwood and Wheeling, W. Va., improvements which will vastly facilitate the transaction of business at those important points. At Benwood a large yard, with 10 miles of track, has been finished, and here the freight business coming west of the Ohio River, as well as that going west from the Main Line and Pittsburgh Division, and Baltimore, will be classified and distributed. The Company is also about to build a commodious passenger station at Benwood, with eating-house and a large round house, with immense shops. The shops now at Wheeling and Bellaire will be removed to Benwood. There has also been constructed at Benwood a connection between the main line and the approach to the Bellaire Bridge, which will enable all trains to pass over without reversing engines or cars.

THE South Baltimore Car Works, Curtis Bay, have arranged to overhaul and paint 250 Wickes Refrigerator Cars for the Baltimore & Ohio Railroad.

## Emery Wheels.

A REPORT has recently been made public of a series of tests of solid emery wheels, made by Messrs. Coleman Sellers, J. E. Denton and Alfred R. Wolff. From this report we take the following extract:

"It was unanimously agreed that hand testing must be done away with and the personal factor eliminated, in order that the results might be unimpeachable. The defect of existing test machines was speedily recognized, and it became necessary to invent a new testing machine. After much study and many trials your Board, with the valuable assistance of Professor Webb, of Stevens Institute of Technology, at Hoboken, constructed a machine which met the approval of all concerned.

"It was agreed, that to constitute a good solid emery wheel, the following qualities should be combined: safety under the widest conditions of use and misuse; rapidity of cut; freedom of cut at moderate pressure; reasonable amounts of wheel loss and power consumption; evenness of wear; general staying quality; and reliability under the widest range of circumstances.

"Our Board then agreed upon a programme of work—had the test machine erected in the machine shop of the Stevens Institute of Technology, at Hoboken—and had the various wheels (bought directly by themselves) delivered at Stevens Institute. The grinding was done on cast-iron bars supplied directly to us by one founder, special care being taken as to quality of metal and size of bar. The trials reported on were made at the Stevens Institute during 1889 and 1890, the tabulations being too voluminous to admit of detail here. During the latter part of this investigation the assistance of Professor Jacobus (Assistant Professor of Experimental Mechanics at Stevens Institute) was secured.

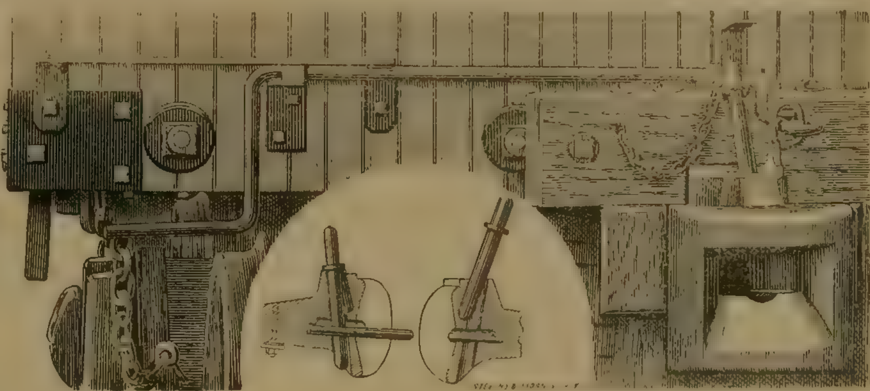
"In preliminary and collateral investigation many trials were made with hand pressure, and some under measured pressures of 10 lbs. and 75 lbs.; but our report is based on a long series of trials at three different pressures—42 lbs., 60 lbs. and 100 lbs. These separate trials numbered several thousand, during each of which exact data were recorded as to speed, power, resistance between wheel and metal, amount of metal ground off, amount of wheel material consumed, and observations made as to the cleanness of cut, amount of heat generated, amount of blazing or clogging up of wheel with metal, and as to cracks, breaks and defects of wheels.

"Of the 15 varieties, six were found too unsafe to warrant their general use, 57 per cent. of the wheels bursting under the same conditions which other wheels passed through uninjured. Eleven varieties (among which are included the six unsafe varieties) were found to be such slow cutters that the average metal removal of 10 of them was less than the general average of all the wheels. Of the 15 varieties only four were found to be rapid cutters. Of these one wore so rapidly that the cost of its rapid cut was unreasonable. This left three safe, effective and satisfactory wheels, one of which, however, was demonstrated to work at a greater cost than the Tanite. The rivalry was thus narrowed to two wheels, and, in the judgment of our Board, further trials are necessary before the relative value of these two can be determined.

"One striking feature characterized these two. That is, that in every series of trials these wheels increased in productive capacity, the average of the last cuts of all the series being greater than the average of all the first cuts. The 13 other varieties all decreased in productive capacity, the average of the last cuts being less than the average of the first. Some of these which made a brilliant show at the start cut scarcely anything at the close."

## The McEntee Coupler.

THE illustration herewith shows the McEntee coupler as



applied to cars on the Northern Pacific Railroad. The inventor states that it has worked well on that road and has given satisfaction, as it couples without difficulty with the common draw-bar. The cut shows the manner in which it is arranged on the car, the smaller view (enclosed in a semicircle near the center) showing a section of the draw-heads. In the engraving the pin is in position just ready to couple.

## Experience with Steel Ties.

IN October, 1889, some steel ties of the pattern made by the Standard Metal Tie & Construction Company were laid in the track of the Chicago & Western Indiana Railroad. The following is an extract from a report made on these ties after two years' use, by Mr. John W. Clarke, formerly Roadmaster of the road:

"I find the total expense on the stretch of 1,000 ft. of steel ties during the 19 months they were in, while I was connected with the road, was $45.50, and the greatest portion of this was caused by the first surfacing done, after track had been laid in the soft ballast, to bring them up to the same elevation as the track on wooden ties alongside. During the same time the cost for labor alone for the 1,000 ft. of track with wooden ties alongside of the steel ties was $210.25, showing enough saved on labor alone to purchase 65 new steel ties.

"The life of the rails, by reason of their being held rigidly upright, must certainly be increased by a good many per cent., and this should go to the credit of the ties. My observation of the lessening of oscillation and vibration on engines and cars, especially on heavily loaded cars of yielding material like grain, leads me to believe that engines and cars running on a road laid with such ties would show a saving in repairs and a longer life. It is also certain that spreading of the rails cannot occur, and that, if a rail breaks, the chances of an accident occurring from that source are reduced to a minimum."

Sections of track have recently been laid with these ties on the Long Island Railroad, near the terminus in Long Island City, and on the Philadelphia & Reading in Philadelphia. In both places they will be subjected to a very severe test.

## PERSONALS.

W. T. JENNINGS has resigned his position as City Engineer of Toronto, Ont., and will re-enter railroad work.

RICHARD H. TALCOTT has resigned his position as Chief Engineer of the Seattle & Eastern Construction Company, and will return to the East.

JOHN C. WILLIS, of Metropolis, Ill., has been appointed a member of the Illinois Railroad Commission in place of JOHN R. TANNER, who has resigned.

H. B. LA RUE, who is well and widely known wherever railroad supplies are bought, is now open to an engagement, having resigned his last position.

GEORGE RICHARDS has been appointed Master Mechanic of the Elmira, Cortland & Northern Railroad, with office at Cortland, N. Y., succeeding THOMAS KEARSLEY, who has resigned.

J. F. O'ROURKE, recently Engineer for the contractors of the Chignecto Ship Railroad, has been appointed Engineer in Charge of Surveys for the Rapid Transit Commission, New York.

H. B. PRINDLE, formerly with the Thomson-Houston Electric Company, has opened an office at 53 State Street in Boston, as an advertising agent for manufacturers, and also for the preparation of catalogues and price-lists.

JOHN E. SPURRIER has been appointed Train-Master of the Baltimore Division of the Baltimore & Ohio Railroad Company, with headquarters at Cumberland, *vice* JOHN BARRON, transferred to the Philadelphia Division.

W. D. CROSMAN, for some time past Editor of the *Railway Master Mechanic*, of Chicago, has resigned that position, and has been appointed Associate Editor of the Consolidated *Railway Age* and *Northwestern Railroader*. Mr. Crosman will have his office for the present in Minneapolis.

EDWARD T. JEFFERY has been chosen President and General Manager of the Denver & Rio Grande Railroad, and will have his office in Denver, Col. Mr. Jeffery was for many years connected with the Illinois Central, rising from a subordinate position to be Superintendent of Motive Power, and afterward General Superintendent and General Manager. He left the Illinois Central in 1889, and since then has been President of the Grant Locomotive Works, of Chicago.

## OBITUARY.

CHIEF ENGINEER JAMES BUTTERWORTH, U. S. N., died in North Cambridge, Mass., October 6. He entered the Navy in 1861 and rose gradually until he was appointed Chief Engineer in 1881. He was a constant student and was considered an authority on modern machinery, and especially on applications of electricity.

ARCHIBALD R. TAYLOR, who died at his home at Pine Bush, N. Y., September 28, aged 84 years, was for many years a civil engineer. He was employed on the original surveys of the Erie Railroad, and was one of the party which began the first railroad survey in Chicago. He retired from active work some years ago.

JOHN BAIRD, who died in New York, October 17, aged 71 years, was of Scotch birth, but passed nearly all his life in America. For a number of years he was connected with the Burden Iron Works in Troy, N. Y., and about 1854 he removed to New York City, where he was connected with the Delamater Iron Works. In 1859 he was appointed Chief Engineer of the Cromwell Steamship Line, and nearly all the boats of that line were designed by him. When the Metropolitan Elevated Railroad Company was organized, Mr. Baird was made Vice-President and Manager; he superintended the building of the road and retained his position up to the time of the consolidation by which the present Manhattan Company was formed.

FREDERICK JARVIS SLADE, who died October 11, aged 49 years, was born in Boston, but removed to New York at an early age, graduated at the City College, and was for a time in the Morgan Iron Works. Subsequently he studied in Europe, and was for some time associated with the late Alexander L. Holley. Nearly 25 years ago he entered the employ of the New Jersey Steel & Iron Company at Trenton, and in 1868 built for that Company the first open-hearth steel furnace in this country. After acting as Engineer of the Company for some years, Mr. Slade was appointed General Manager, and held that position until his death. He was considered a high authority on metallurgical questions, and wrote a number of valuable reports and papers.

JOEL BENEDICT HARRIS, who died in Rutland, Vt., October 19, aged 69 years, was born in Sterling, Conn., and graduated from the Rensselaer Polytechnic Institute at Troy, as a civil engineer, in 1840. After working at his profession for some years he became a contractor, and did some heavy work on the Harlem, the Boston & Albany, the New York & New Haven and other roads. In 1860 he settled in Rutland, and there established the Rutland Foundry Company, manufacturer of car wheels and other castings. This concern was reorganized in 1882 as the Harris Manufacturing Company, and Mr. Harris remained President until his death; he was also President of the Springfield Foundry Company at Springfield, Mass. He leaves a widow and six children.

## PROCEEDINGS OF SOCIETIES.

**Master Car Builders' Association and American Railway Master Mechanics' Association.**—The following circular has been issued by the Joint Committee of Arrangements, consisting of Messrs. R. C. Blackall, J. W. Marden, E. Chamberlain, O. Stewart and Angus Sinclair:

NEXT CONVENTIONS.

The Joint Committee of the above Associations, empowered to select the place of meeting for the next Conventions, met at Buffalo on September 7, and decided on Saratoga, N. Y.

Congress Hall Hotel has been selected as the headquarters of both Associations. The members and all others attending the Conventions will receive accommodation at the uniform rate of $3 per day. Application for rooms should be made to H. S. Clements, Congress Hall, Saratoga, N. Y.

As the second Wednesday of June happens on the 8th next year, and as there was difficulty in getting a hotel to open so early, the Executive Committees of the two Associations decided to postpone the Conventions one week. Under this arrangement the Master Car Builders' Convention will meet on Wednesday, June 15, and the Master Mechanics' Convention on the Monday following.

**American Society of Mechanical Engineers.**—The twelfth annual meeting will be held at the Society's house, No. 12 West Thirty-first Street, New York, beginning Monday evening, November 16. At this meeting the usual routine business will be transacted, officers for the ensuing year elected, and there will be several sessions for the reading of papers and discussions.

Secretary F. R. Hutton has issued a circular stating that a proposition has been made to hold the spring meeting of 1892 in California. The question has come before the Council, and it has been decided to accept invitations from the Pacific Coast, provided the members at large approve of the selection. The cost for the journey will not exceed $300 each, including visits to prominent points of interest, and may be reduced if a sufficient number of members accept.

**American Railway Association.**—The fall meeting of this Association—formerly called the General Time Convention—was held in New York, October 14. The President, Colonel H. S. Haines, made an interesting address on the Cost of Transportation, noting the elements which should enter into it and the manner in which it should be estimated.

Mr. Willard A. Smith, Director of Transportation Exhibits of the Columbian Exposition, addressed the meeting on the plans made for this work, and the prospects for carrying it out. Resolutions were passed in favor of this work. Resolutions were also passed expressing interest in the timber tests now being made by the Department of Agriculture.

The Car Service Committee made a report, saying that the system of Car Service and Demurrage Associations, so far as carried out, was working very successfully.

The Committee on Safety Appliances reported progress, and submitted a resolution, which was adopted, to the effect that continuous steam heating should be the standard system of the Association, and that lighting with high-test oil is practically safe.

The Committee on Train Rules reported that the standard code is now in use on 109 roads, operating 76,000 miles, and that 17 more roads with 7,000 miles were soon to adopt it. The Committee recommended no change in rules.

A delegation from the Train Dispatchers' Association presented some suggestion concerning new rules, which were received, acknowledged, and referred to the Committee on Train Rules.

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**American Society of Railroad Superintendents.**—At the fall meeting in New York, October 12, several amendments to the constitution were adopted. The report showed that there were now 198 members.

The Committee on Transportation reported on some questions in train dispatching, stating that the questions were very complicated, and that they had not been able to recommend a final answer.

The Committee on Roadway made a report, discussing tie-plates and some patent spikes, and holding that 80 lbs. per yard was about the heaviest rail section to be recommended. If additional support was needed, it would be better to increase the number of ties. This report was discussed at some length.

The Committee on Machinery made a report on Car Heating, and on the Use of Malleable Iron in Car Construction; they stated that a regulator for controlling the degree of heat in cars was much needed.

Mr. W. G. Wattson read an interesting paper on Economy in Train Service, which was discussed at some length. At the close of this discussion it was resolved that the Committee on Transportation be instructed to prepare a catechism for the examination of trainmen.

A Committee of seven on Signaling was appointed to report at the next meeting. It consists of Messrs. J. J. Turner, James Donnelly, C. H. Platt, J. H. French, C. D. Hammond, W. G. Wattson, and O. E. McClellan.

Mr. Willard A. Smith was introduced, and made an address on the Transportation Exhibit at the Columbian Exhibition. At its close the Executive Committee was directed to take up the matter.

The following officers were elected: President, H. Stanley Goodwin; Vice-Presidents, C. W. Bradley, G. W. Beach; members of Executive Committee, R. G. Fleming, O. M. Shepard.

In the evening the meeting and the tenth anniversary of the Society were celebrated by a dinner at the Hotel Brunswick, at which about 40 members were present, and which was much enjoyed.

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**American Institute of Mining Engineers.**—The fall meeting was held at Glen Summit, Pa., beginning October 6, and was largely attended. At the opening meeting addresses were made by Honorable Eckley D. Coxe, Chairman of the Local Committee, and by President Birkinbine, who referred to the work done by the Institute and the number of important papers brought out by it.

A number of important papers were read at this meeting. Among them were one by M. B. Holt, on Electricity in Mining; by H. O. Flipper, on Mining Surveys in Sonora; by W. H. Blauvelt, on Uses of Anthracite Waste; and by Albert L. Colby, on Nickel Steel. There were also discussions on Concentrating Iron Ores; Government Timber Tests; Tests of Iron and Steel and other subjects.

During the meeting the members visited a number of mines in the Lehigh Region.

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**American International Association of Railroad Superintendents of Bridges & Buildings.**—This Association was organized at a meeting held in St. Louis, September 25, at which 60 persons were present or represented. After a temporary organization a Committee on Constitution and By-Laws was adopted, and presented reports, which were accepted. The following gentlemen were elected officers: President, O. J. Travis; Vice-Presidents, H. M. Hall, J. B. Mitchell, James Stannard and G. W. Hinman; Secretary, C. W. Gooch; Treasurer, George M. Reid; Executive Committee, N. A. MacGonagle, W. R. Damon, G. W. Markley, G. W. McGehee, J. E. Wallace, and G. W. Turner.

After some general discussion, it was decided to hold the next annual meeting in Cincinnati, on the third Tuesday in October, 1892. The following subjects were selected for report and discussion: 1. Surface Cattle Guards. 2. Frame and Pile Trestles. 3. Protection of Wooden Bridges against Fire and Decay. 4. Iron and Vitrified Pipe for Culverts. 5. Water Tanks and Accessories. 6. Interlocking Signals. 7. Station Platforms. 8. Paints for Iron Structures.

A committee of three members was appointed upon each of these subjects, to report next year.

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**American Association of Railroad Clerks.**—This Association, which was organized at Cleveland, O., last year, held its second convention in St. Louis, September 16–18. At the opening session addresses of welcome were made; and President J. H. Hanna delivered the annual address, in which he stated that there were now 16 local organizations attached to the Association, with nearly 1,100 members. The Secretary's report showed a prosperous condition.

On the second day a number of amendments to the constitution and by-laws were presented and referred, and the routine business was despatched. In the evening the visiting delegates enjoyed a banquet at the Lindell Hotel, given by the local association.

On the third day resolutions were adopted against strikes, and some changes in the constitution were approved. The following officers were elected for the ensuing year: Grand President, George A. Round, Boston; First Grand Vice-President, P. P. Walsh, Cairo, Ill.; Second Grand Vice-President, W. G. Staley, Troy, N. Y.; Grand Secretary, Frank L. Solomon, Boston; Grand Treasurer, W. C. Pearce, Cleveland, O.; Grand Door-keeper, J. R. Allen, Cincinnati, O; Executive Committee, W. F. Moore, W. J. Russell, R. M. Conlish, C. Manlove, N. M. Leach and George B. McGuire; Grand Trustees, E. H. Bassett, George H. Leonard and C. W. Eagan.

Philadelphia was selected as the place for holding the next yearly convention.

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**American Society of Civil Engineers.**—At the regular meeting in New York, October 7, the following candidates were declared elected:

*Members:* Casper W. Haines, Guatemala; Charles F. B. Haskell, Wenatchee, Wash.; Alfred A. Stuart, Newport, Ky.

*Associate Members:* Frederick W. Abbott, Zumpango, Mexico; George E. Gifford, Cleveland, O.

A paper on Screw Steamship and Tow Barge Efficiency on the Lakes, by Joseph R. Oldham, was read. The second paper was by Captain O. M. Carter, U. S. Engineers, on Experiments with Dynamite on an Ocean Bar. This was discussed by Messrs. Collingwood, Brush, Reed, North and Bogart, who described work done on the bars in New York Harbor and elsewhere, Mr. Collingwood referring to some successful work now being done with the centrifugal pump in the removal and dredging of sand bars.

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**New England Railroad Club.**—At the regular meeting in Boston, October 14, the subject for discussion was Lighting of Passenger Cars, which was opened by Mr. F. D. Adams, who advocated the use of oil lamps, especially the Sherburne lamp. He was followed by Messrs. Coghlan, Lauder, Dickson, Oldham, Butler, Richards, Chamberlain, and others, the merits of the Pintsch gas system and of the oil lamp being presented from different standpoints. It seemed to be generally agreed that electric lights for cars were still too expensive for general use.

**New York Railroad Club.**—The first meeting of the season was held at the Club rooms, in New York, September 17. No paper had been prepared for the meeting, but a discussion was had on the best method of Setting Tubes in Locomotive Boilers. This subject was discussed by Messrs. G. W. West, W. H. Lewis, Blackall, Kells and others. The general practice seemed to be the use of copper ferules either with or without swaging the tubes. A number of subjects were suggested for future meetings, and it was understood that besides formal papers, there would be a discussion on one topic at each meeting.

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**Engineers' Club of Philadelphia.**—At the regular meeting, June 20, reports were presented upon the International Engineering Congress and the Incorporation of the Club.

Mr. Charles S. Churchill read a paper on Rail Joints, referring to the defects in existing joints, and describing a plan devised by himself for avoiding them. This paper was discussed by Mr. Trautwine and others.

The tellers reported that the following had been elected Active Members of the Club: Messrs. James McCann, S. W. Putnam, Neville B. Craig, D. W. Taylor, John Overn, Abraham Bruner, Charles L. Prince, John V. W. Reynders, Frederick Bloch, O. M. Weand, William J. Smith, Henry Howson, George McCall, George L. Van Zandt, W. W. Stevens, Clarence M. DuBois; and that Mr. Albert Priestman had been elected an Associate Member of the Club.

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At the regular meeting, October 3, a paper was read by Mr. Trautwine, compiled from data furnished by Captain S. C. McCorkle upon Land-locked Navigation from New York to Charleston. A written discussion of this paper by J. Foster Crowell, of New York, was also read. The paper was verbally

discussed by members present. Some resolutions which were offered, constituting a memorial to Congress in favor of the scheme, were postponed until the next meeting.

A paper by Mr. Saunders Morris on the Electrical Transmission of Power was read, and also a letter from Mr. Coleman Sellers giving information with regard to the transmission of power from Lauffen to Frankfort.

Mr. B. H. Coffey read a paper on the Effect of Centrifugal Force on the Transmitting Power of Driving Ropes, giving formulas based upon experiment. These papers were briefly discussed.

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**Civil Engineers' Club of Cleveland.**—A regular meeting was held on Tuesday evening, September 9, with President Gobeille in the chair and 18 members present. The Secretary being absent, Mr. C. M. Barber was chosen Secretary *pro tem.* Mr. Henry A. Barren and Perry L. Nobbs were elected active members.

It was voted to have a visiting day, when the members of the Club in a body will visit the different manufacturing establishments of Cleveland and engineering works in the vicinity, and a permanent committee was appointed to designate the days and arrange programmes.

President Gobeille then read an interesting paper on Straw and Corn on the Cob as Fuel for Domestic Purposes, in which it was stated that it had been found from experiments that the same quantity of heat could be generated by the combustion of straw or corn on the cob, pound for pound, as could be generated by the combustion of any other fuel. One of the principal difficulties in designing stoves for burning straw is to provide for the liquid products of combustion which are comparatively large in quantity. Several drawings of different stoves designed for burning straw were exhibited, also diagrams showing temperature curves obtained by platting colorimeter and pyrometer readings from experiments recently made. The difficulties of burning lignite, and the need of stoves for burning this material, which abound in many parts of the country destitute of true coals, was also discussed. The result of ten experiments were platted against lines derived from similar treatment of bituminous coal.

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**Engineering Association of the South.**—The first fall meeting was held in Nashville, Tenn., October 9. The Nominating Committee submitted a list of names for officers to be balloted for at the annual meeting in November.

The following new members were elected: Frank Cowley, Benjamin W. Robinson, Earlington, Ky.; Thomas D. Kemp, Mobile, Ala.

Mr. W. H. Ross read a paper on Estimation and Measurement of Earthwork, comparing several methods now in use and showing their errors as compared with the prismoidal formula. One of the conclusions was that since earthwork excavations are usually bounded by a concave profile, the prismoidal formula gives results less than the actual volume taken out. The method of "averaging and areas" was considered the most correct. The author presented some tables devised by himself, and showed some graphical scales for the same purpose, and to be used in finding the center of a mass of excavation.

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**Southern & Southwestern Railroad Club.**—At the regular meeting in Nashville, Tenn., September 24, there was a discussion on Breaking of Locomotive Side Rods. A letter from a superintendent of motive power was read, and diagrams of some curious breakages were shown.

Mr. Robert Walker read a paper on Draft Gear for Freight Cars, which was discussed at some length.

The election of officers for the ensuing year resulted as follows: President, R. D. Wade, Richmond & Danville; First Vice-President, Pulaski Leeds, Louisville & Nashville; Second Vice-President, James Meehan, Queen & Crescent; Treasurer, A. G. Steinbrenner, American Refrigerator Transit Company. The Secretary for the past year, Mr. W. H. Marshall, resigned, and it was decided that the selection of some one to fill the vacancy should be postponed until the November meeting.

Atlanta was chosen as the next place of meeting, the date being November 19.

The subjects for the next meeting are Uniformity in Reports of Locomotive Performance, and Repair Work on Large Roads; whether it can best be done by concentration in large shops or by distribution among smaller shops.

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**Western Railroad Club.**—At the regular September meeting in Chicago, which was the first meeting of the season, the Secretary presented a report covering the last year's work of the Club. He said that there are now about 225 members, and that the publication of the Club *Proceedings* in pamphlet form had resulted very satisfactorily.

The following officers were elected for the ensuing year: President, P. H. Peck; Vice-Presidents, W. H. Lewis and Joseph Townsend; Secretary, W. D. Crosman; Treasurer, Allen Cooke.

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At the regular meeting in Chicago, October 20, the first topic for discussion was Air-Brake Practice, continued from the September meeting. Brake experts and representatives of brake companies were invited to attend the meeting.

The second subject was Water Purification, on which a paper was read by J. N. Barr, of the Chicago, Milwaukee & St. Paul Road.

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**Northwestern Track & Bridge Association.**—At the regular meeting in St. Paul, October 16, the report of the members who were present at the Convention of the Roadmasters' Association was presented, and some discussion was had on that subject.

A paper was presented by Mr. Rafferty on Proper Foundation for a Right-Angle Crossing, which was discussed by members present. There was also a discussion on Mr. Gonagle's paper on Preservation of Bridge Timber, which was read at the September meeting.

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**Northwest Railroad Club.**—At the regular meeting in St. Paul, October 20, the first subject for discussion was Painting Rolling Stock, on which a paper was read by Mr. J. O. Pattee.

Mr. P. H. Conrad read a paper on Fuel and Economy in its Use. Both papers were generally discussed by members present.

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**Technical Society of the Pacific Coast.**—At the regular meeting in San Francisco, October 2, six new members were elected.

Mr. T. W. Morgan read a paper on Sewer Systems and the Purification of Gases from Sewers. He also exhibited models of traps, showing charcoal in a channel through which noxious gases are made to pass. The paper and the systems recommended were discussed by the Society.

M. Manson's paper on the Cause of the Glacial Period, read at the preceding meeting, was also discussed.

## NOTES AND NEWS.

**Breaking of Locomotive Side Rods.**—At a recent meeting of the Southern & Southwestern Railroad Club a letter was read from the Superintendent of Motive Power of a road which was not named, describing some breakages of locomotive parallel rods. The road in question uses solid-end rods of steel, with oil-cup forged on the end, of the pattern shown in fig. 1. The steel used is of good quality, as shown by the fact that

FIG. 1.

FIG. 2.

FIG. 3.

FIG. 4.

tests of specimens from broken rods showed an ultimate strength of from 70,700 to 73,100 lbs., with an elongation of 23 to 29 per cent.

Figs. 2 and 3 show different views of a rod which was broken in service, the cause being the breaking of the driving axle close to the hub of the wheel. The rod broke short off, but was twisted into a spiral before it broke.

Fig. 4 shows another rod which was twisted into the form illustrated, but did not break. Still another rod of the same kind broke while the engine was running, but no cause could be assigned, and tests showed the material to be fully equal to that of the others. Open-hearth steel is used for all these rods.

**An English Express Locomotive.**—The accompanying illustration, from the *Railway Engineer*, is a fair specimen of the express locomotive as built in England by those engineers who still adhere to the inside cylinders—which most of them

do—and to the single drivers—which many do not. This engine was built by Neilson & Company, Glasgow, Scotland, for the Caledonian Railway, and has run 100⅝ miles in 102½ minutes with a train weighing—including engine and tender—168 tons.

The engine, as shown in the cut, has a four-wheeled truck forward, a single pair of drivers, and a pair of trailing wheels behind the fire-box. The total wheel-base is 21 ft. 1 in. The grate area is 17.25 sq. ft. and the total heating surface 1,053 sq. ft. The boiler is of iron, the fire-box of copper, and the tubes of brass. It is fitted with Adams' "vortex" blast-pipe.

The cylinders are 18 in. in diameter and 26 in. stroke; the driving-wheels are 7 ft. in diameter. The frames are of the plate type, of steel and the pedestal jaws of cast-iron, those for the driving axle being fitted with packing pieces to take up the wear of the axle-boxes. The axle-boxes are of gunmetal lined with white metal. The slide-bars and blocks are of cast iron, as are also the eccentric straps and sheaves.

The total weight of this engine in working order is 92,850 lbs., of which only 38,080 lbs. are carried by the drivers, 29,680 lbs. resting on the truck, and 25,090 lbs. on the trailing wheels.

**A New Method of Cleaning Sewers.**—In a recent number of the *Wochenschrift* of the Austrian Engineers' Union, Herr Emil Sokal describes a contrivance invented by him for the purpose of clearing the sludge in the Warsaw sewers, where the fall is too slight to admit of its being removed by the ordinary means of flushing. Recently some 25 miles of new drains have been laid in Warsaw, but out of about 900 houses in the neighborhood only 250 drain into them, the remainder being connected with the old drains of the city, which receive also the rubbish from the houses and the street sweepings, and occasionally are so blocked with deposit as to resist the ordinary flushing power, and manual labor has to be resorted to.

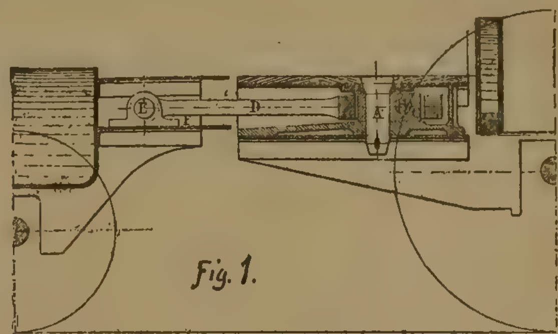
The fall of the new sewers is generally sufficient to keep the bottom clean by flushing only, but there are two or three places where the fall is less than 1 in 1,000, and therefore require special arrangements. Warsaw also had a network of old wood and brick drains nearly three parts full of mud and deposit, which led straight to the river Vistula by the shortest cut. The new main sewer runs parallel to that river, and is frequently crossed by these old drains. Connections with the new sewer were made at these crossing points, and this arrangement seriously affected the discharge of the new sewer.

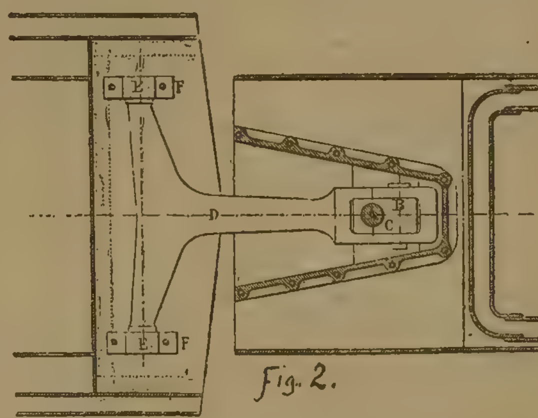
At certain intervals, dependent on the fall, flushing-gates are built in the sewer, and on the whole this arrangement answers its purpose completely, but in some places, as before mentioned, deposits are met with which resist the flushing power and necessitate removal by hand.

With a view to do away with this manual labor, Herr Sokal, in 1889 (after an examination of the methods adopted under similar conditions in Munich, Zurich, Lausanne and Berlin), prepared the following simple contrivance. A wooden templet or mould fitted to the profile of the sewer, rests on a batten 1½ in. thick, which is pointed at the end for the purpose of penetrating and loosening the sludge. The flushing sluice above the portion of the sewer to be cleaned is closed, and water allowed to accumulate. About 6 or 10 ft. lower down the templet with pointed scraper is set up; the sluice is now opened and the scraper, which is under the control of a workman, moves on and clears the deposit. If this be very solid and hard, a small shutter in the templet is opened and water sufficient to thin it is admitted, or the scraper may be used more than once at the desired spot.

**A German Tender Coupling.**—The accompanying sketch shows a coupling between the locomotive and tender which has been adopted for the fast passenger engines of the Wurtemburg State Railroads. These locomotives are of a new design, and are compound engines of the Von Borries type. The illustrations, which are from the *Organ für die Fortschritte des Eisenbahnwesens*, show in fig. 1 a section, and in fig. 2 a plan.

The coupling is designed to give full play in all directions, at the same time making a close and secure connection. The link *D* is held by the two studs *E E*, which fit in the brackets *F F* bolted to the frame of the tender, as shown. The forward end of the link *D* is a slotted yoke, in which is placed the block *C*, which is held in place by the horizontal pin *B*. The coupling-pin *A* passes through the block *C* and the drawhead. This drawhead is of cast iron, strengthened by a wrought-iron plate riveted on the lower side; it is bolted to the heavy iron plate which connects the locomotive frames at the rear end.



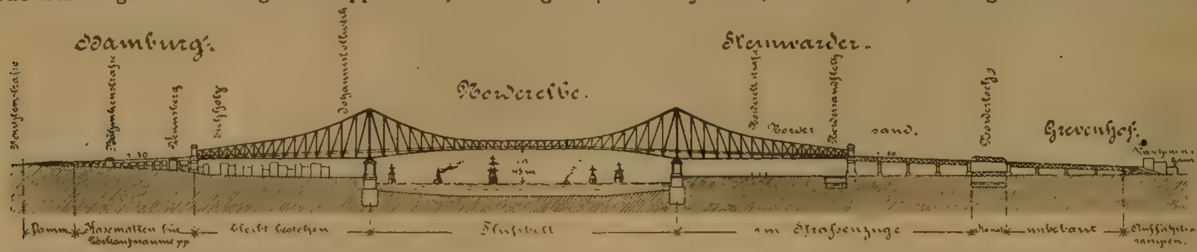

This coupling has been in use a year without perceptible wear. The coupling-pin *A* is 4.33 in. in diameter.

**Color-Blindness.**—A railroad engine-driver, 40 years of age, was dismissed from his situation because he was unable to correctly distinguish colors. Dr. M. Reich, who examined the man, and who afterward published the results of his examinations in a Russian paper, found sight, focus, and sensation of light normal, and discovered no disease by the ophthalmoscope, yet the patient could distinguish no colors when of a dark shade, and only yellow and blue when of a light shade. With the help of a red glass he could distinguish the figures on Tables II, III, VII, and VIII (Stilling). The patient assured Dr. Reich that he had been able to distinguish colors correctly and with confidence up to the summer of 1889. He said that through over-exertion and insufficiency of sleep he had then

suffered from violent headache for two weeks, and that afterward he saw everything as if it were red. The latter symptom had continued for three months, after which time he had lost all sensation of color. In the beginning of May, 1890, he presented himself again, declaring that he had perfectly regained his power to distinguish colors. A thorough examination completely confirmed the assurance given by the patient, who was consequently again fit for service. Dr. Reich believes that "erythropsy" is due to central mischief. The case seems to show that sensation of color is perfectly independent of the physiological function.—*London Lancet.*

**A German High-Level Bridge.**—The accompanying sketch, from the *Deutsche Bauzeitung*, shows a design prepared for a high-level bridge over the Elbe, to connect the city of Hamburg with the suburbs on the opposite side of the river. Such a connection is much needed, and surveys have been made for a tunnel under the river, but with very unsatisfactory results.

The total length of the bridge and approaches, according to the plan, will be 4,920 ft. On the Hamburg side the approach will be carried on stone arches; on the opposite side it will be a viaduct supported on stone piers. It is intended to carry a roadway, two sidewalks and double line of tramway tracks.



The bridge proper will be a cantilever structure having a total length of 2,952 ft., divided as follows: Shore arms, 787.2 ft. each, 1,574.4 ft.; river arms, 492 ft. each, 984 ft.; connecting span, 393.6 ft. The river span, consisting of the two river arms and the connecting span, will have a clear opening of 1,377.6 ft. between the piers, and a clear height of 147.6 ft. above high water. The trusses will have a total depth of 229.6 ft. at the piers.

The building of this great bridge is now under consideration; it is in charge of a commission appointed by the Senate of Hamburg.

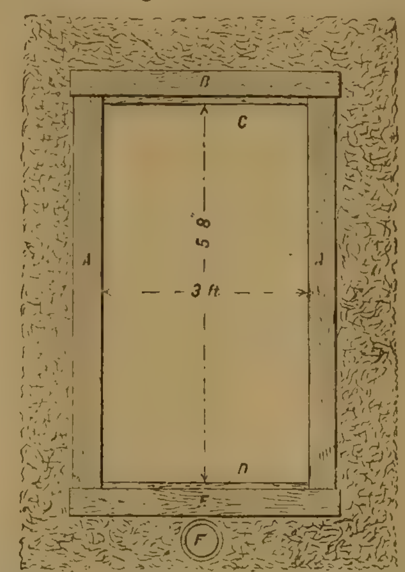
**Old Standards.**—By a curious accident it has just been discovered that the English standard yard and other measures and weights which were supposed to have been lost when the Houses of Parliament were destroyed by fire in 1834 are still in existence. The following account of the matter is condensed from a statement in the London *Times*. A reference to the contemporary records shows that after the fire the standard bars of 1758 and 1760 were both found among the ruins, "but they were too much injured to indicate the measure of a yard which had been marked upon them." The principal injury to both of the standards was the loss of the left-hand gold stud, but whether this was caused by the action of the flames or otherwise is not known. When the Palace of Westminster was rebuilt the two bars were deposited in the Journal Office, and from that time, until the other day, they seem to have been wholly lost sight of. About a fortnight ago it happened to be stated in the lobby that one of the duties of the Speaker was to inspect once in every 20 years the standards immured in the sill of the Lower Waiting Hall. Inquiries at the Standards Department of the Board of Trade elicited the fact that, so far from any statutory requirement being imposed upon the Speaker in the direction indicated, Section 35 of the Weights and Measures Act, 1878, which provides for the care and restoration of the Parliamentary copies of the Imperial standards, specially exempts the walled-up copy from periodical inspection and comparison. It was found, however, that in 1871 Speaker Denison took cognizance of the standards; and this fact was brought to the Speaker's notice. While inquiries were being made as to Speaker Denison's inspection, an official in the Journal Office mentioned that when the contents of that office were recently being transferred to the new wing he had observed among the lumber some old weights and measures. These proved to be the missing standards. On Tuesday last they were examined by Mr. Chaney, the Superintendent of Weights and Measures; and on Wednesday the Speaker was to visit the Journal Office for the purpose of inspecting them.

"The most important of the standards thus rescued from oblivion are the yard measures constructed by Bird in 1758 and 1760. The former was copied from a bar in the possession of the Royal Society, which was itself a copy of a standard preserved in the Tower; and the second was constructed under the directions of a Committee of the House of Commons from the 1758 standard. "Each of these two standard yards consisted of a solid brass bar 1.05 in. square in section and 39.73 in. long. Near each end of the upper surface gold pins or studs 0.1 in. in diameter were inserted, and points or dots were marked upon the gold to determine the length of the yard." The other standards in the custody of the Journal Office are two brass rods answering the description of the old Exchequer yard, and four weights supposed to be certain of the "copies, model, patterns, and multiples" ordered by the House on May 21, 1760, "to be locked up by the clerk and kept by him." The most important weight—the standard troy pound—is not among those now brought to light.

**Tunnel Timbering.**—From *Industry*, of San Francisco, which abounds in ideas, we take the following: "The Editor of *Industry* has had occasion to construct a tunnel. Not for gold, that being wholly unnecessary, because of emoluments of this Journal, but for water, which gold will sometimes not produce. This tunnel is timbered as in the diagram. Whether new or old is not known, but it certainly differs from common practice. The side timbers *A* are 3 × 12 in.; the cap *B* also 3 × 12 in. The foot timber *E* is 2 × 12 in., and the two strut pieces *C* and *D* are 1 × 12 in., all of redwood, cut to lengths at the mills and delivered ready for setting.

"The timbering consists, when complete, of a series of frames 12 in. deep, the top being 4 in. thick and the sides and bottom 3 in. thick. One peculiarity is that one of these frames is set as soon as the heading is advanced one foot. One man can set the timbers, which is performed as follows: A sewer, *F*, is first laid down, then the base piece *E* is set and leveled, the abutting piece *D* being first nailed on. Then the uprights or sides are set, and the cap *B* put in place. There has been no caving and no difficulty of any kind this far.

"Another, and the main peculiarity is, that the material removed before timbering is much less than when frames and lagging are used—at least 25 per cent. less. Another point is that the tunnel is completely floored and dry, and water collected is preserved from fouling, or standing in contact with the timbers.




"The mouth of the tunnel was framed up like a house and a shed for tools made over it at the start, the cutting beginning through a door frame of the size noted on the sketch. The timbers are white-washed inside the tunnel wherever dry enough to admit of that; and as another departure the floor is swept out at intervals, and the whole carried on in a clean, orderly way. There is no loss, but, on the contrary, a gain by these methods over the usual slovenly way of working."

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ALL subscribers to the RAILROAD AND ENGINEERING JOURNAL should receive with the present number the Index and Title-page for Volume LXV (Volume V, New Series). Should any fail to receive it, they can have the omission supplied on notifying this office. The volume covered by this index includes the twelve numbers for the year 1891.

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A PETITION is to be presented to Congress this month, signed by a large number of ship-owners and others in all the lake cities, asking for increased appropriations for the purpose of maintaining lights of a permanent character on the lakes, and a greater number of lighthouses seem to be much needed, and also an increase in the number of lightships and beacons. The increase of commerce in the last few years has been so large, and the number of vessels now employed and the value of their freight is so great that more attention to this point is really warranted, and it is to be hoped that the petition will be effectual. A government survey and wrecking vessel is also much needed, and should be provided.

THE lake shipping interests are preparing to urge upon Congress a continuation of the work to be done upon the channels at various points, for the purpose of maintaining at least 21 ft. depth of water from Buffalo to the upper end of Lake Superior. The amount of work to be done to form and maintain such a channel is very large, and it is a question whether the attempt will be wholly successful. The lake shipping interests are very large, but if more attention were paid to the designing of ships to carry a heavy load on a small draft, the 21-ft. channel might be unnecessary.

THE monument at Bordentown, which is elsewhere described, is worthy of imitation, not only because it is in itself very simple, tasteful and appropriate, but also because such memorials should be increased in number. It is an excellent practice to preserve the memory of historical events by monuments, and the railroad history is fully as important in its way as the political and warlike history of the nation. Much credit is due to Mr. Watkins for suggesting the Bordentown monument, and to the officers of the Pennsylvania Railroad Company for the way in which the suggestion has been carried out.

THE death of Mr. Moncure Robinson at the advanced age of 90 years removes the last of the older generation of engineers. Mr. Robinson was a contemporary of Benjamin H. Latrobe, John Stevens, William Cook, Ashbel Welch and the other engineers who laid the foundations of our railroad system and gave form and direction to its development. He was one of the few who foresaw the future of the railroad, for he was an early advocate of it in preference to the canal; and it is said that when he located the Philadelphia & Reading Railroad, his colleagues were confounded by the extent of the provision he thought necessary for terminals.

Mr. Robinson retired from the active work of his profession so long ago that he was little known to the present generation of engineers; but he was often called in consultation, and was noted for his kindness to younger men and his willingness to give advice.

THE lake which was formed during the present year at Salton in the Colorado Desert by water overflowing from the Colorado River is now, it appears, gradually decreasing in size by evaporation, and it is said that the current of water which fed it and caused its formation has been cut off. In that case it will be only a short time before it disappears, on account of the extremely rapid evaporation prevailing in that part of country.

THE supply of copies of the RAILROAD AND ENGINEERING JOURNAL for June, 1888, is entirely exhausted. As we need a few, any subscriber who may have a copy of that date, and who does not preserve his files, will confer a favor upon the JOURNAL by sending it to the office. For any copy of that issue sent in, the sender will receive a credit of *two months* on his current subscription.

## ENGLISH AND AMERICAN LOCOMOTIVES.

### II.

#### LOADS HAULED.

IN our article on this subject published last month, brief reference was made to the consumption of coal by British and by American engines. Of course, in any comparison of fuel consumption account should be taken of the loads hauled. Unfortunately only a few of our American railroad companies—and, so far as

TABLE V. SHOWING THE AVERAGE NUMBER OF PASSENGER AND FREIGHT CARS HAULED, THEIR WEIGHT, AND FUEL CONSUMED PER MILE, AND PER TON PER MILE.

| 1 | Passenger Trains. | | | | Freight Trains. | | | |
|---|---|---|---|---|---|---|---|---|
| Name of Road. | 2 Av. No. of Cars per Train. | 3 Weight of Train, exclusive of Engine and Tender. | 4 Lbs. of Coal Consumed per Mile. | 5 Lbs. of Coal Consumed per Ton of Cars. | 6 Average No. of Cars per Train. | 7 Weight of Train, exclusive of Engine and Tender. | 8 Lbs. of Coal Consumed per Engine, Mile. | 9 Lbs. of Coal Consumed per Ton of Cars. |
| | No. | Tons of 2,240 lbs. | lbs. | lbs. | No. | Tons of 2240 lbs. | lbs. | lbs. |
| Chesapeake and Ohio | 4.52 | 123.2 | 63.65 | .516 | 18.9 | 472.5 | 127.4 | .248 |
| Chicago and Alton | 5.20 | 139.7 | 72.3 | .517 | 20 32 | 508.0 | 96.1 | .189 |
| Cincinnati Southern | 4.3 | 117 9 | 55.0 | .466 | 22.8 | 570.0 | 98.0 | .172 |
| Cleveland, Cincinnati, Chicago and St. Louis | 4.5 | 122.8 | 63.21 | .514 | 21.4 | 535.0 | 106.7 | .197 |
| Illinois Central | 4.49 | 122 4 | 74.9 | .612 | 15.36 | 384 0 | 108.4 | .282 |
| Louisville and Nashville | 5.11 | 137.4 | 60.5 | .440 | 13.11 | 327.7 | 93.3 | .284 |
| Michigan Central | 5.5 | 147.0 | 72.71 | .494 | 32.0 | 800 0 | 128.0 | .160 |
| New York, Lake Erie and Western | 4.9 | 132.4 | 85 0 | .641 | 21.8 | 545.0 | 122.4 | .224 |
| New York, Pennsylvania and Ohio | 5.1 | 137.2 | 70.0 | .511 | 19.1 | 477.5 | 117.9 | .247 |
| Pennsylvania (Philadelphia to Pittsburgh) | 4.95 | 133.6 | 67.5 | .505 | 24.37 | 609.25 | 136.0 | .223 |
| " (Lines West of " ) | 5.33 | 142.8 | 58.87 | .412 | 23.87 | 596.75 | 100.3 | .168 |
| Philadelphia and Erie | 3.84 | 106.9 | 60.0 | .552 | 32.66 | 816.5 | 153.8 | .188 |
| Averages* | 4.81 | 130.3 | 66.97 | .515 | 22.14 | 553.5 | 115.7 | .215 |

* These are the averages of the averages of each road.

we know, none of the British lines—publish any statistics which show what their train loads are. Table II, published last month, shows that some of the companies whose reports have been tabulated therein do report the average number of cars, of both passenger and freight trains, and the average consumption of coal per mile for both. These figures have, for convenience of comparison, been condensed in Table V, in which the name of the road is given in the first column, and the average number of passenger and freight cars per train in the second and sixth, and the pounds of coal consumed per engine mile for each class of trains in the fourth and eighth.

To determine the weight of the average train, all that can be done will be to make an approximation; but this may be sufficiently close to the actual weight, so that the difference will not be sufficient to affect materially the deductions therefrom.

The average passenger train, it may be assumed, consists of a baggage, a mail, or an express car, whose weight loaded will be about 60,000 lbs.; a dining, drawing-room, or sleeping car, whose loaded weight will be about 80,000 lbs., and the balance of the train will consist of ordinary passenger cars or coaches, whose weight with the passengers will be about 54,000 lbs. each. If, then, it is assumed that each train consists of one baggage car, one sleeper, and the rest ordinary passenger cars, the approximation to the actual weight will be sufficiently near to enable us to draw deductions therefrom. The weight of the average passenger trains, contained in Table V, has been calculated in this way, and is given in tons of 2,240 lbs. in the third column. By dividing this weight into the pounds of coal consumed per mile shows the quantity of coal consumed per ton of cars per mile. This is given in column 5. From this it will be seen that the average consumption of coal for passenger train is almost exactly one-half a pound per ton per mile.

In the sixth column of the table the average number of freight cars per train for the different roads is given. It may be said that this number is reduced to loaded cars, two empties being generally rated as one loaded, or in some cases five empties are rated as three loads. To determine the weight of these cars, we must again resort to a process of deduction. We have before us the report of some experiments made on the Illinois Central Railroad in 1889, which gives the weights of empty cars as follows:

| | | |
|---|---|---|
| 100 | Box cars. | |
| 71 | Coal " | |
| 5 | Refrigerator cars. | |
| 5 | Flat or platform cars. | |
| 1 | Fruit car. | |
| 6 | Tank | cars. |
| 5 | Caboose | " |
| 5 | Passenger | " |
| 2 | Stock | " |
| 45 | Class unknown | " |
| Total 245 | | |

of which the aggregate weight was 5,767,895 lbs., or an average of 23,542 lbs. each. These cars composed the average trains of the traffic on the road named. To confirm this, the following weights are given of different classes of freight cars on the Pennsylvania Railroad:

| | |
|---|---|
| Box car | 20,300 lbs. |
| " " | 24,900 " |
| " " | 27,800 " |
| " " | 29,600 " |
| Flat or platform cars | 19,900 " |
| " " " | 22,100 " |
| Gondola " | 23,100 " |
| Hopper gondola " | 20,700 " |
| " " " | 23,200 " |
| Drop bottom " | 26,400 " |
| " " " | 29,300 " |
| " " gondola cars | 18,500 " |
| Stock or cattle " | 19,000 " |
| " " " " | 26,200 " |
| Dead hog " | 27,200 " |
| Refrigerator " | 38,300 " |
| Charcoal " | 28,600 " |
| Total | 425,100 " |
| Average | 25,006 " |

It is probable that the cars of the Pennsylvania road are

somewhat heavier than the average through the country. Besides, the proportion of the lighter cars, such as flat or platform and cattle cars, in ordinary trains is greater than of the heavier class, like refrigerator and heavy box cars. For this reason we will take the average weight of the cars on the Illinois Central trains, and assume that an average loaded freight car weighs 23,000 lbs.

In the report referred to the weight of the loads of 214 cars is also given, and amounts to 7,927,819 lbs., or an average of 37,046 lbs. In the last annual report of the Pennsylvania Railroad Company the average car load for the year is given at 16.79 tons (of 2,000 lbs.) = 33.580 lbs. Therefore, if we assume the average car load to be equal to 33,000 lbs., we are quite certain that the assumption is not higher than the actual weight. By adding this average load to the weight of the empty car = 23,000 lbs. gives us 56,000 lbs. = 25 tons of 2,240 lbs. as the average weight of loaded freight cars, which is surely a very close approximation to the actual weight under the ordinary conditions of traffic in this country. With these figures, the weight of the average freight trains given in Table V has been calculated, and will be found in column 7. Dividing this into the pounds of coal consumed per freight engine mile, gives, as in the case of passenger trains, the coal consumed per ton of cars per mile. The average for the twelve roads given in the table is .215 lbs. per ton per mile.

Owing to the fact that the weight of trains on British roads is not reported, or even recorded, it is impossible to make any comparisons of the relative fuel consumption per ton per mile in the two countries from the figures given in our tables. In the one relating to English locomotives, published last month, it will be seen that the fuel consumption is not even given separately for passenger and freight trains, and, so far as we know, no data are obtainable concerning the average weights of either class of trains.

In a recent English book on the railway rates question,* the author, who seems to be thoroughly familiar with the subject, in referring to the low rates at which freight is carried in this country, says : "No accurate comparison with these figures is possible in the case of the English railways, because the necessary statistics are not in existence. We know that in round figures 300,000,000 tons were carried at a cost of £40,000,000 sterling—at an average cost, that is, of 2*s.* 8*d.* per ton. Supposing the average distance traveled to have been 20 miles, this would be roughly equivalent to 1½*d.* per ton mile ; or, supposing the distance to have been 32 miles, it would be equivalent to one penny. Probably the truth is that the distance was nearer the shorter than the longer figure. *If we say that English traffic paid on an average 1¼d. per ton per mile, our guess will probably be as near the truth as it is possible to go.* The 50 or 60 per cent. reduction which the American railways have achieved is therefore, without doubt, a feat of which they have every right to be proud."

Taking Mr. Ackworth's guess—and it is that of a man apparently thoroughly acquainted with the subject—as representing the nearest approximation possible to the average British rates, and then taking the average traffic receipts for goods trains per mile, contained in Table I, and dividing the one by the other, and we have an average

* "The Railways and the Traders ; or, Sketch of the Railway Rates Question in Theory and Practice," by W. M. Ackworth.

train load of only 56.6 tons. If the weight of the "wagons" is equal to the paying load, the total weight of train would be 113.2 tons ; if the dead weight of cars is twice the load, the total weight of train would be 169.8, or, say, 170 tons.

This latter weight is less than a third as much as the average weight of freight trains on the twelve American roads given in Table V. Of course it is impossible to draw any quantitative conclusion from such imperfect data, but they indicate very distinctly why the consumption of fuel by American freight engines per train mile is greater than that of the same class of English locomotives.

Happily *The Engineer* has given us some more specific data concerning the performance of English freight engines. In its issue of November 7, of last year, a tabular statement was published in which the performance of new goods engines was reported on different gradients on the North British Railway, between Glasgow and Carlisle in the winter of 1876–77. The trial was carried out by Mr. Drummond, then the locomotive superintendent of that line, in order to test the relative merits of the injector and the feed-pumps as boiler feeders. Table VI is a reprint of *The Engineer's* report of this test. It will be seen that in the tenth column of this table the fuel consumption is reduced to the quantity burned per mile per ton of train or cars. The average for the 16 trials was .272 lbs. per ton per mile. This, it will be observed, was during a trial, to which special attention is always attracted, and therefore better results are attained than in ordinary practice. On the other hand, the figures given in Table V are the results of a whole year's working on 12 different roads in this country. It will be seen that the average consumption with freight trains on the 12 American roads was only .215 lbs. per ton of train per mile, whereas on the North British road it was .272, a performance which the Editor of *The Engineer* seems to think represents at least good, if not the best performance of an English freight engine.

We are able, however, to compare this test on the North British road with a similar one on the New York Central road, which was made last year under the supervision of Mr. Buchanan, the Superintendent of Machinery of that line. As the weight of the trains is given in the report of the North British tests, and also in that of Mr. Buchanan's experiments, it is possible to compare the consumption of fuel per ton mile on each road.

The trial on the New York Central road consisted of nine round trips between Buffalo and Dewitt, a distance of 150 miles, so that the whole distance run during the tests was 2,700 miles. The engine was of the mogul type and weighed in working order 120,000 lbs. = 53.5 tons (of 2,240 lbs.). The weight on driving-wheels was 104,500 lbs. = 46.6 tons. The driving-wheels were 64 in. in diameter, the cylinders 19 × 26 in. The average speed of trains was 15.8 miles per hour. The steepest grade eastward was 34 ft. per mile ; westward it was 42 ft. In order to compare the New York Central trials with those on the Scotch road, under as nearly the same conditions as possible, we have selected, for comparison, from the latter the six runs which were made "up ruling gradients of 1 in 100" = 52.8 ft. per mile, and "up and down ruling gradients of 1 in 900" = 5.8 per mile, and have tabulated the average results of these and the New York Central trials in Table VII.

The average train load in the New York Central test (col-

TABLE VI. NORTH BRITISH RAILWAY. PERFORMANCE OF NEW GOODS ENGINES ON DIFFERENT GRADIENTS BETWEEN GLASGOW AND CARLISLE. WINTER OF 1876–77.

Engine No. 281, pumps, exhaust-cocks under foot-plate, feed-water supplied to boiler at average temperature of 127°. Consumption of coal from monthly sheets.

Engine No. 305, pumps, exhaust-cocks under cylinders, feed-water supplied to boiler at average temperature of 107¾. Coal specially measured.

Engine No. 292, injectors, consumption of coal specially measured.

All three engines are of the same class, 18 in. × 26 in. cylinders, and 5-ft. wheel-cylinder power 140.4; adhesive weight, 39½ tons. No. 281 evaporates 8.95 lbs. of water per lb. of coal; No. 305 evaporates 8.24 lbs.; and No. 292 evaporates 8.21 lbs.

| Gradients. 1 Average. | Gradients. 2 Maximum. | Ruling Gradients. | 4 No. of Engine. | 5 Average Speed whilst in Motion. | 6 Average Distance between Stops—Traffic, Water and Signals. | Average Weight. 7 Train—Van, Wagons and Load. | Average Weight. 8 Engine and Train. | Coal. 9 Per Train Mile. | Coal. 10 Per Mile, per Ton of Train. | Coal. 11 Per Mile, per Ton of Engine and Train. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | *Miles per hour.* | *Miles.* | *Tons.* | *Tons.* | *Lbs.* | *Lbs.* | *Lbs.* |
| 1 in 85 | 1 in 70 | Up ruling Gradients of 1 in 70. | 281 | 13.20 | 12.44 | 290.0 | 356.0 | 95 00 | 0.327 | 0.267‡ |
| 1 in 84 | 1 in 75 | | 305 | 16.20 | 8.34 | 229.0 | 295.0 | 98.51 | 0.430 | 0.334‡ |
| .......... | 1 in 70 | | 305 | 11.40 | 10.00 | 211.5 | 279.0 | 131.06 | 0.619 | 0.470§ |
| 1 in 92 | 1 in 70 | | 292 | 13.10 | 13.60 | 233.0 | 300.0 | 106.04 | 0.454 | 0.354‡ |
| 1 in 260 | 1 in 100 | Up ruling Gradients of 1 in 100. | 281 | 17.20 | 10.04 | 268.0 | 334.0 | 68.00 | 0.254 | 0.204 |
| 1 in 333 | 1 in 100 | | 305 | 20.95 | 8.20 | 194.3 | 260.0 | 70.58 | 0.363 | 0.271 |
| 1 in 351 | 1 in 100 | | 392 | 19.40 | 10.97 | 220.8 | 287.0 | 68.53 | 0.310 | 0.239 |
| Level | 1 in 900 | Up and down ruling Gradients of 1 in 900, or practically level. | 281 | 18.96 | 10.10 | 247.5 | 314.0 | 46.10 | 0.186 | 0.147 |
| Level | 1 in 900 | | 305 | 21.80 | 7.00 | 247.4 | 314.0 | 52.62 | 0.213 | 0.168 |
| Level | 1 in 900 | | 292 | 24.12 | 7.94 | 222.0 | 288.0 | 50.16 | 0.226 | 0.178 |
| 1 in 220 | 1 in 75 | Down. | 281 | 21.00 | 7.40 | 302.0 | 368.0 | 30.50 | 0.100 | 0.083 |
| 1 in 205 | 1 in 75 | | 305 | 24.30 | 31.00 | 275.5 | 341 8 | 31.18 | 0.113 | 0.091 |
| 1 in 528 | 1 in 75 | | [illegible] | 28.80 | 31.40 | 211.9 | 278.0 | 25.60 | 0.121 | 0.092 |
| Averages of about 1,000 miles, with each engine running similar goods trains between Glasgow and Carlisle, *via* Waverley route. | | | 281 | 18.40 | 8.78 | 267.0 | 333.0 | 49.50 | 0.185 | 0.149 |
| | | | 305* | 19.80 | 8.23 | 244.6 | 311.0 | 56.39 | 0.230 | 0.182 |
| | | | 292† | 20.50 | 8.88 | 230.6 | 297.0 | 53.36 | 0.231 | 0.180 |
| General Averages....... .............. | | | . . . . | ... ..... .. | ........... | 243.4 | ... ........ | 64.56 | 0.272 | ........... |

* Number of wagons—loaded, 30.95; empty, 5.40; total, 36.35; equivalent number of loaded wagons, 34.55.

† Number of wagons—loaded, 26.66; empty, 9.53; total, 36.19; equivalent number of loaded wagons, 33 02.

‡ Assisted by pilot. § Without pilot.

umn 6) was 1,212 tons, in the North British 233.3. The weight of train hauled in the former test was 22.6 times the weight of the engine; in the latter it was only six times. The total weight of the English engine was not given, but it is said that the adhesive weight was 39½ tons. As the ordinary type of goods locomotive on British roads is a six-wheeled engine, all the wheels being drivers and all coupled, it is inferred that this was the type of engine used, and that the adhesive weight was also the total weight.

The distances run, the average speed while in motion, the ruling grade, the average number of cars hauled and their aggregate weight, the total weight of engines and weight on driving-wheels are given. The proportion of the weight of locomotive to that of the cars hauled has been calculated, the pounds of coal consumed per mile run, and per ton per mile are all given. The coal consumed per mile (column 10) by the North British engine was 59.3 lbs., while Mr. Buchanan's machine burned 127.7 lbs., or more than twice as much as the other. But if we compare the amount of fuel burned per ton of train per mile (column 11), the proportions are reversed, as the Scotch engine burned .254 lbs., while the American consumed only .105 lbs. per ton per mile. Comment is unnecessary.

It may be said, however, and very properly, too, that in railway traffic there are always two kinds of trains: one, the loads of which are limited by the number of passengers or freight to be carried, and another, the weight of which is limited only by the capacity of the engine. Thus on coal roads, and on most of our through lines, there is an unlimited amount of freight to be transported, whereas on lines doing a local freight or passenger business the number of people and the tonnage to be carried does not exceed a certain number or amount. The cost of the former traffic should be estimated at its cost per ton per mile, the latter in terms of the cost per train mile. We will take up the total cost of motive power per ton of train first.

To do this the subject of

REPAIRS

must be considered. During the discussion, of which this article is a part, the Editor of *The Engineer* has complained that he has invariably failed to obtain any trustworthy information concerning the cost of repairs in the United States. We have, therefore, been at considerable pains to collect information with reference to this point, which is given in Table II, published last month. It will be seen from column 11 of that table that the average cost of repairs on the 41 roads included in the table was 4.25 *cents per mile run.* The average cost on the British roads, included in Table I, was 5.3 *cents.* The difference appears the more remarkable when the fact that our engines haul much heavier trains is taken into consideration, and that the cost of labor and material are both higher here than it is in England, Scot-

TABLE VII. SHOWING THE COMPARATIVE RESULTS OF TESTS OF FREIGHT LOCOMOTIVES ON THE NORTH BRITISH AND THE NEW YORK CENTRAL RAILROADS.

| NAME OF ROAD. | 2 Distance Run. | 3 Average Speed while in Motion. | 4 Ruling Grades. | 5 Average Number of Loaded Cars in Train. | 6 Weight of Cars in Train, with their Loads. | 7 Total Weight of Locomotive. | 8 Weight on Driving-Wheels of Locomotive. | 9 Proportion of Weight of Locomotive to Weight of Train. | 10 Lbs. of Coal Consumed per Mile Run. | 11 Lbs. of Coal Consumed per Ton of Train (Exclusive of Engine and Tender) per Mile. | 12 Value of Coal Consumed per Mile at 1 Mill per Lb. | 13 Cost of Repairs of Engine per Mile. | 14 Cost of Oil, Waste, and Supplies per Mile. | 15 Wages of Enginemen, Firemen, and Cost of Cleaning and Attendance per Mile. | 16 Total Cost of Locomotive Service per Engine Mile. | 17 Total Cost of Locomotive Service per Ton of Train (Exclusive of Engine and Tender) per mile. | 18 Cost of Conductors and Brakemen per Mile. | 19 Total Cost of Locomotive and Train Service per Mile. | Cost of Locomotive and Train Service per Ton of Train (Exclusive of Engine and Tender) per mile. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Miles. | Miles per Hour. | Feet per Mile. | No. | Tons of 2,240 lbs. | Tons of 2,240 lbs. | Tons of 2,240 lbs. | | Lbs. | Lbs. | Cts. | Cts. | Cts. | Cts. | Cts. | Cts. | Cts. | Cts. | Cts. |
| North British........ | 3,000 | 20.4 | 6 and 52 | ...... | 233.3 | 39.5 | 39.5 | 1 to 6 | 59.33 | .254 | 5.93 | 3.06 | ...... | 8.64 | 17.63 | .075 | 4.8 | 22.43 | .096 |
| New York Central... | 2,700 | 15.8 | 34 and 42 | 48.67 | 1212.0 | 53.57 | 46.65 | 1 to 22.6 | 127.70 | .105 | 12.77 | 2.61 | .33 | 6.25 | 21.96 | .018 | 6.2 | 28.16 | .023 |

land, and Ireland. More than a year ago our adversary took occasion to remark, that "it is very difficult to understand how, seeing that labor and materials are all more expensive on the other side of the Atlantic than here, the work of repair can be done for less money." We can't explain why our cotemporary has difficulty in understanding the undoubted fact, which is shown by the figures in our table, but it is a fact, nevertheless, and it is due to the better designs of our engines, which have been made or evolved more with reference to facility of repair than English locomotive designs have been. We hoped to be able to show wherein our plans and methods of construction are better than those of our cousins, and the reasons for the diminished cost of repairs, by comparing the drawings of the different parts of a typical English and American locomotive; but our cotemporary declined to accede to our proposition to publish complete engravings of one of their engines, on condition that we should publish similar engravings of one of our locomotives.

It does not seem necessary to emphasize the advantages which American locomotives have from their greater facility of repair. As a consequence in great part of this their average mileage is nearly 50 per cent. greater than that of English engines, while at the same time the cost of repairs here per mile run is 1.05 cents less than that of the latter.

If the cost of repairs on the American roads enumerated in Table II had been as great as it is on British lines, the total extra cost would have been nearly *five and a half millions of dollars.* Our table includes less than half the locomotives and mileage of the country, so that if all our roads were equipped with English engines it would involve an *extra annual expenditure in this country of over* $10,000,000. Nor is this all. As our engines are hauling heavier trains than English engines are, if the cost of repairs of American engines was estimated in proportion to the work done, it would be relatively still less than that of British engines, and the increased cost if the latter were used would be much greater than the above enormous sum.

Next month we will give some data and make some comparisons of the total cost of locomotive service in this country and in England.

(TO BE CONTINUED.)

## THE RECENT ARMOR TESTS.

SINCE our last issue a noteworthy trial of armor plate has been going on at the Naval Ordnance Proving Ground at Indian Head, Md.—noteworthy not only on account of the results obtained, but also from the fact that it is the first trial, under modern conditions, of American-made armor, and that it will determine for some time to come the character of the plate to be supplied to our new navy.

It will be remembered that at the Annapolis trial of last September between an English compound and the French steel plates, the victory of the nickel-steel seemed so pronounced that a large appropriation was secured from Congress for the purchase of this metal. But it was felt that no hasty decision should be made, and that a single trial was hardly sufficient to determine just how far the presence of nickel improved the resisting power of a steel plate.

In the tests under consideration three questions are to be settled: 1. Whether or not the plates should contain nickel; 2. Whether they should be of moderately high or of mild steel, and 3. Whether face-hardened or homogeneous throughout. The first trial was had on October 31, the competing firms being the Bethlehem Iron Company and Carnegie, Phipps & Company, of Pittsburgh. Three plates were submitted for test: by the former firm, one of low carbon, all steel, face-hardened by the Harvey process, and a second of untreated high carbon nickel-steel; the Pittsburgh firm came forward with an untreated low-carbon nickel-steel plate. It should be stated that the Bethlehem plates are hammered; those from Pittsburg are rolled. Generally speaking, the low-carbon plate contains from 0.20 to 0.25 of 1 per cent. of carbon; the high carbon from 0.30 to 0.40 of 1 per cent.

The plates were all of the uniform size of 6 ft. × 8 ft. × 10½ in., backed by 3 ft. of oak, thoroughly braced, and supported by a bank of well-rammed earth, and mounted upon the arc of a circle 30 ft. from the muzzle of

the gun. The test was to be four 6-in. shot delivered at the four corners of a square 2 ft. from the edge, and an 8-in. shot in the center of the plate. The 6-in projectiles were 100-lb. armor-piercing Holtzer shell fired from the new 40-caliber rifle, with a muzzle velocity of 2,075 foot-seconds, the charge being 42 lbs. brown powder. The 8-in. projectiles were 210-lb. armor-piercing Firminy shell, having a velocity of 1,850 foot-seconds, the charge being 74½ lbs. of brown powder.

After the four rounds per plate from the 6-in. gun neither of the nickel-steel plates showed a crack, while the all-steel had developed several very serious fissures. The final 8-in. shot started cracks in both the nickel plates —in the high-carbon rather more than in the low-carbon plates—while the all-steel plate was in a very demoralized condition, and may be said to have been put out of the fight. Of the two nickel plates, the high carbon Bethlehem had thrown back every one of the five projectiles, the penetrations being from 9 to 16½ in. The low-carbon Pittsburgh plate had admitted of a penetration almost double that of its rival, four out of the five projectiles being so deeply imbedded in the metal that they, in all probability, would have burst in-board had they been loaded, the penetrations being from 13½ to 29½ in.

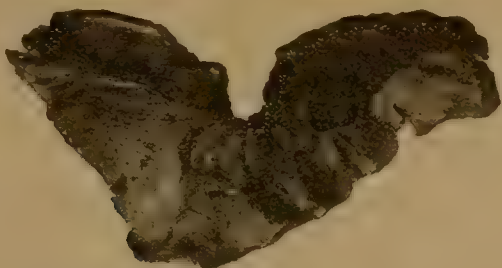
The second trial took place on November 15. The plates submitted were a high-carbon untreated and a low-carbon Harvey-treated nickel-steel from Carnegie, Phipps & Company, and a high-carbon, Harvey-treated nickel-steel from the Bethlehem Works. The conditions were practically the same as on the previous trial, except that with the 8-in. gun Carpenter projectiles were used against the two Carnegie plates, and an English Firminy against the Bethlehem plate—an undoubted advantage to the former. The Carnegie high-carbon untreated plate threw back the five projectiles, but admitted penetrations of from 9⅝ in. to 12½ in. Cracking began at the end of the fourth shot on this plate, which the last round increased to a dangerous degree. The low-carbon Harvey-treated plate of this firm behaved in much the same manner as its low-carbon plate at the previous trial, only its ability to resist penetration had been increased in a marked degree, accompanied, however, by a greater disposition to crack. The penetrations were from 9¾ in. to 20¼ in. Three projectiles remained imbedded in the plate. The last shot cracked this plate badly in both directions from the center. The Bethlehem high-carbon hardened nickel-plate was, at the end of the fourth round, practically uninjured. On the left side of the plate the projectiles had penetrated about 12 in. and rebounded ; on the right side what appeared to be blotches upon the surface proved to be, on closer inspection, the points of the projectiles broken off and welded to the metal of the plate. The last shot started cracks from the center through the upper and lower left-hand holes to the edge of the plate.

The accompanying illustration is a photograph of two pieces of the Bethlehem high-carbon plate ; fig. 1 shows the natural appearance of the steel, and fig. 2 is from the point of impact of the 8-in. shell. The difference is interesting.

The lack of uniformity in the tempering process was shown very markedly not only in the case of the last plate mentioned, but to a greater or less degree with all of the plates tested, and upon both days. Some means for securing a uniform degree of hardness over the whole surface of the plate will undoubtedly be devised.

This first showing in the manufacture of armor-plate was, for both the competing firms, a most creditable one ; and it is doubtful if, taking into consideration the quality of the projectiles and the high velocities employed, equally good results have ever before been attained in the fabrication of armor.

Fig. 2.



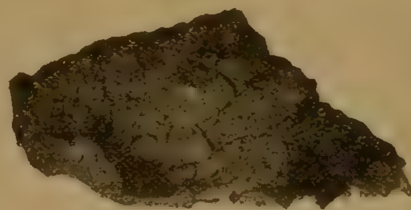


Fig. 1.

Two more plates remain to be tested ; but whether the rival firms will be content to rest their case upon the tests already had, or proceed to further trial, is unknown. In either case, it seems safe to predict that the decision of the Board will lie between the high-carbon, nickel-steel face-hardened plate of the Bethlehem firm, or the low-carbon nickel similarly treated plate of its Pittsburgh rival, with the chances in favor of the former as the matter now stands.

## CAR COUPLERS.

At a meeting of Railroad Commissioners of the different States, held March 3 last, a committee was appointed to secure action by Congress looking to uniformity in safety appliances for railroad cars. This Committee gave a public hearing to the representatives of different railroad companies and organizations of railroad employés in the rooms of the Chamber of Commerce, in New York, on November 10. A report of this hearing will be found on another page.

In sending out the call for the meeting, Mr. Moseley, the Secretary of the Committee, stated "that as 6,000 railroad employés were killed and 26,000 injured for the year ending June 30, 1889, and that the number is constantly increasing, therefore the importance of the subject is manifest not only to those directly concerned in railway operations, but to those who are interested in the cause of humanity." The appalling amount of pain and suffering which is indicated so faintly by the above figures would justify the use of much stronger language than that employed by the Secretary, who has done so much for the cause for which the meeting was held. To ignore the duty which is imposed on every railroad manager and every person who can exert any influence in lessening this awful amount of suffering is to incur a fearful responsibility. The members of the Committee who had charge of this meeting seemed to feel this responsibility ; nevertheless, after a full hearing of all the parties who desired to be

heard, the Committee separated without reaching any conclusion, but with a more profound impression of the great difficulties with which the whole subject is surrounded than they had before the meeting was held. Those who gave their opinions and experience at the meeting also went away with the same impression.

The problem may be stated thus : The loss of life and limb being as indicated by the statistics quoted, how can it be diminished most, either by congressional legislation or otherwise ? To this question no answer was given at the hearing.

All who attended the meeting were, however, agreed that one great cause of accidents in coupling cars was the want of uniformity in coupling appliances. The diversity, instead of being diminished by the action of the Master Car-Builders' and the American Railroad Association in adopting the vertical plane type of coupler, has been increased. The introduction of this new type has not only increased the diversity in the *species* but in the *genus* of couplers, which makes the danger much greater than a diversity of species does. Not only has the adoption of the Master Car Builders' type resulted in introducing a new genus, but it has led to the evolution of many new species of that genus, so that the present danger to the poor trainmen who must couple cars is now greater than ever before. The multiplication of the species goes bravely on, and unless checked in some way, the sacrifice of life and limb promises to go on at an increasing ratio. The imperative necessity for some preventive measure therefore becomes more urgent daily. The action which was contemplated by at least some members of the Committee who conducted the hearing was legislation by Congress making the adoption of the Master Car Builders' type of coupler compulsory on all railroad companies. To this there are, however, very grave objections. It is an American foible to suppose that almost any evil may be cured by legislation. It may be added that the more ignorant the legislators are, the greater is the number of subjects which they want to legislate about. Some of the objections to such legislation were very clearly summed up by Thomas Henry Farrer, the Permanent Secretary to the British Board of Trade, in giving his evidence, in 1877, before a royal commission appointed to inquire into the causes of accidents on railroads. He then said :

> General interference with the administration of railroads is objectionable on the following grounds :
>
> (*a*) By such interference you are setting two people to do the work of one. Double management is notoriously inefficient. One bad general is better than two good ones.
>
> (*b*) You set those who have less experience of management and less personal interest in the result to control those who have more.
>
> (*c*) Control is either apt to become formal and a sham, or if zealously and honestly exercised, to be rigid, embarrassing and a hindrance to improvement.
>
> (*d*) Many excellent things, the adoption of which is desirable for public safety—*e.g.*, the block system, interlocking points and signals, efficient brakes, properly constructed tires (car couplers might have been added) are not things which can be once for all settled, defined and prescribed, but things of gradual growth, invention and improvement. Had any of these been prescribed by law at any past time, they probably would not have been what they are now ; and were they now prescribed and defined by law, future improvement would be checked. This is a most insidious form of evil, for we do not know the good which we thus prevent. It is no answer to say that Government control would be intelligent and would encourage improvement. It is not Government or its officers who invent or adopt inventions, and those who do so are far less likely to improve when Government has defined and prescribed a definite course, the adoption of which frees them from responsibility.

With reference to uniformity of car couplers, there is also the difficulty that there is no unanimity of opinion among those who are most interested in the subject. The Master Car-Builders and the American Railroad Associations have adopted the Master Car-Builders' type of coupler ; but there are still an influential minority of railroad officials who are opposed to its use. The switchmen and yardmen appear to condemn it. Owing to its adoption by the associations referred to, it is being applied in a variety of forms to large numbers of cars ; and it is useless to disguise the fact that its introduction thus far has increased instead of lessening the danger of the perilous occupation of coupling cars. In the present attitude of the question it is hopeless to expect to create immediate unanimity of opinion. This must be the result of evolution. It would be promoted very much if a brief report was made of each accident which occurs from coupling cars, giving the date and hour of the accident ; how it was caused ; the kind of coupler on each of the cars ; the owners of the cars ; the height of the draw-bars ; their defects, if any, and the extent of the injuries to the person who was engaged in coupling. These particulars are intended only as suggestions, and are not by any means comprehensive. Doubtless others could be added to advantage.

Now, the legislation which is suggested is, that railroad companies should be required by Act of Congress to report to the Inter-State Commerce Commission, or some other body, all these and possibly other particulars regarding every accident from coupling cars which disabled the victim, and that full reports of such accidents be published monthly or quarterly—that is, oftener than once a year—so as to have more influence on railroad officers and the public than annual reports would have. Such reports would show which are the most dangerous couplers, would indicate the causes of accidents, and thus influence the opinions of railroad officers and the public, and tend to unanimity. Data of this kind would be analyzed by the technical newspapers, and if it once appeared that any form of coupler was specially dangerous, no railroad company could long continue its use in the face of adverse public opinion.

In an endeavor to bring about uniformity of couplers, the railroad associations have heretofore attempted to adopt some one standard. Such action has thus far failed in accomplishing its object. Whether it will ever succeed is still an open question. At any rate, there is now greater diversity than ever before. Now while there is no sufficient ground for pronouncing such action a failure, yet thus far it has not accomplished its object. How would it do, then, to attack the problem from the other or negative side ?—that is, if we can't bring about uniformity, let us try to lessen diversity. Supposing that the members of the American Railroad Association should agree not to use any *new* pattern of coupler until it was approved by a committee of their own body appointed for the purpose. Then let them appoint a competent committee to sit in judgment on all new couplers, whether of the link-and-pin or vertical plane type which might be submitted to them for use by members of the Association. Such a committee might co-operate with a similar committee of the Master Car Builders' Association. Probably it would be found that investigations, experiments

and tests of couplers would require the services of a competent mechanical man, who could give as much of his time to the work of the committee as might be required. Without such assistance the work would be sure to be done in a more or less perfunctory way, as few or none of a committee could give more than a very limited amount of time to such duties. The person employed would do the real work of the committee, but under its advice, direction and approval; at the same time the action of the committee would be formulated by its own members.

One topic more: all interested—that is, railroad commissioners, railroad managers, car-builders, yardmen, switchmen and brakemen—are unanimously agreed that the height of draw-bars of freight and passenger cars should be uniform. The Master Car-Builders' Association has adopted the height of "2 ft. 9 in., measured perpendicularly from the tops of the rails to the center of the draw-bar when the car is empty," as the standard height for freight cars. To fix a maximum limit—say 2 ft. 11 in. and a minimum of 2 ft. 7 in.—and require railroad companies to conform thereto would not be a hardship. At present there is no general conformance to the Master Car Builders' standard of height.

If any compulsory legislation is adopted by Congress looking to uniformity and to hasten the equipment of freight cars with uniform automatic couplers, its provisions should for the present be confined to the adoption of the standard height of draw-bars, and to a requirement to report in detail the circumstances and causes of each accident, and these should then be made public by the authority to which they are reported every month or every quarter.

In the mean while, the American Railroad Association has also the duty of at least lessening the diversity of couplers, which is now increasing and not diminishing. Railroad companies argue against compulsory legislation to secure uniformity of safety appliances with bad grace, if at the same time they keep on increasing the diversity by their own action.

## NEW PUBLICATIONS.

A Treatise on the Construction and Use of Milling Machines as Made by the Brown & Sharpe Manufacturing Company. The Brown & Sharpe Manufacturing Company, Providence, R. I.; price, paper, 75 cents, or cloth, $1.60.

This treatise is written chiefly for those who are not familia- with the use of the milling machine, but contains much matter of interest to those who are well acquainted with that excellent tool. It has special reference to the machine as made by the Brown & Sharpe Company, but its information is, of course, applicable to any machines of this class. It is of considerable size, having 162 pages, 94 illustrations and a number of tables.

Among other things it may be mentioned that a new classification of cutters is given, and much space is taken up by the consideration of the proper number of teeth in cutters, the best speed for mills and similar topics. Many milling operations are fully described, and there are chapters on Indexing, Compound Indexing and Cutting Spirals. The illustrations include views of a number of different machines, different forms of cutters, etc., and diagrams of changes.

Mexico. Bulletin No. 9 of the Bureau of the American Republics. Prepared by Arthur W. Fergusson. Issued by the Bureau of the American Republics, Washington.

This volume is similar in design and arrangement to the previous issues of the Bureau, and especially to the book on Brazil, which was recently noticed in the Journal. It contains a condensed historical sketch followed by a general description of the country, its natural features, resources, products, etc. There are chapters on public lands and land laws; immigration and colonization; wages, cost of living and conditions of labor; taxation, tariffs and nature of government; with a variety of other information. An appendix contains a description of the various railroad and steamship lines; a directory of the officers of the General Government, and a general mercantile directory. There is also an excellent map of the country.

The work of the Bureau of the American Republics appears to be well and carefully done. Its object has been previously referred to, and the publication of these monographs on the different countries of Central and South America should have excellent results.

Streets and Highways in Foreign Countries. *Reports from the Consuls of the United States on Streets and Highways in their Several Districts.* Issued from the Bureau of Statistics, Department of State, Washington.

This volume contains a number of reports sent in by United States Consuls, in answer to a circular from the State Department, giving information as to the condition of roads and methods of road-making in the countries where they are stationed. In Europe there are reports from Austria, Belgium, Denmark, France, Great Britain, Germany, Holland, Italy, Spain, Switzerland and Russia; in America, from Canada, Mexico, several of the South American States and the West Indies; and there are also reports from China, Australia and Egypt.

Some of these reports are excellent, and all of them contain some information. Many of them are illustrated by diagrams showing methods of construction and other details. Particulars of the cost of construction and maintenance are given in most cases, and the volume makes a serviceable book of reference.

It is of particular service at the present time, when so much attention has been called to the improvement of roads in our own country. A comparison of methods will be of service, and the statements of cost will be found convenient. The volumes issued by the State Department contain much useful matter, and the present one is especially worthy of note.

The Transit. No. 1, 1891. Issued by the Engineering Society of the State University of Iowa; Iowa City, Ia.

This is the first half-yearly number for 1891 of this publication, which is now in its second year, and which has been so far very creditable to the society of students by which it is maintained. The present number contains several excellent papers, two of which, at least, will attract attention among engineers. The first of these is the paper of Mr. Alden H. Brown, on Testing Cement by a Microscopic Method, which calls attention to the differences in structure or physical condition of different cements, and to the relation which exists between this structure and their strength and other properties. It is accompanied by a number of plates from photographs, showing the appearance of different cements under the microscope. These are very striking and are well worth a careful study by engineers who have to use cement. The suggestions made in the paper are good, and the whole matter is new and worth attention.

The other paper referred to is by Mr. E. A. Wallberg on Secondary Strains, and is a carefully written and well-studied account of the graphical method of determining these strains in bridge trusses.

The remaining papers are good and deserve more attention than space permits us to give them here. The Engineering Society of the Iowa University is apparently organized for serious work, and deserves credit for the progress shown in this volume.

## TRADE CATALOGUES.

*Chain Blocks. The Yale & Towne Manufacturing Company, Stamford, Conn.*

This is an illustrated catalogue describing the various forms of the Weston differential pulley-block as manufactured by the Yale & Towne Company, with the addition of a report on the comparative efficiency of different blocks by Professor Thurston. Tables of dimensions required for various loads and other convenient data are included.

*A List of Horizontal Boring and Drilling Machines. The Nicholson & Waterman Manufacturing Company, Providence, R. I.*

This is a very neat and handsomely illustrated catalogue of the boring and drilling machines built by the company named. It is headed by the appropriate motto "Bore Away," and gives a list of a variety of machines of this class.

*Ward's Patent Sectional, Safety, High-pressure Boiler or Steam Generator. Charles Ward, Charleston-Kanawha, W. Va.*

This is an illustrated circular describing the Ward tubulous boiler, which has been heretofore described in our columns It is accompanied by a reprint, in pamphlet form, of the report of the Board of Engineer Officers of the Navy on the tests of this boiler, and the competitive tests of various coil and tubulous boilers. It was as a result of these tests that the Ward boiler was adopted for the new coast-defense ship *Monterey.*

*Steam Pumping Machinery. The Deane Steam Pump Company, Holyoke, Mass. General Catalogue of Steam Pumps and Pumping Machinery.*

*The Horton Lathe Chuck: Illustrated Catalogue. The E. Horton & Son Company, Windsor Locks, Conn.*

## BOOKS RECEIVED.

*Professional Papers of the Corps of Royal Engineers: Volume XVI.* Edited by Captain W. A. Gale, R.E. The Royal Engineers' Institute, Chatham, England.

*Reports of the Consuls of the United States to the Department of State: No.* 131, *August,* 1891. Washington; Government Printing Office.

*Some Experiments to Determine the Strength of American Vitrified Sewer Pipe.* By Professor Malverd A. Howe. This is a reprint, in pamphlet form, of a valuable paper read by Professor Howe before the Engineers' Club of St. Louis.

*Proceedings of the Fourth Annual Convention of the Train Dispatchers' Association of America and of the Train Dispatchers' Mutual Benefit Association.* This is a very full report of the convention of the Train Dispatchers' Association, which was held in Toledo, O., in June last. It is issued in the form of a supplement to the *Telegraph Age.*

*Papers of the Institution of Civil Engineers.* London, England; published by the Institution. The latest of these papers received include the Design of Locomotive Cylinders, by J. H. Barker; the Proposed Railroad through Siberia, by W. M. Cuningham; Abstract of papers in Foreign Transactions and Periodicals.

*Report of the Sixth Annual Meeting of the Illinois Society of Engineers & Surveyors: held at Springfield, Ill., January* 28–31, 1891. Springfield, Ill.; published for the Society; price, 50 cents. This volume contains a number of papers read at the annual meeting, with reports of the discussions.

*Transactions of the American Institute of Mining Engineers, Volume XIX: May,* 1890, *to February,* 1891, *inclusive.* New York; published by the Institute.

*Catalogue of the Michigan Mining School; with Statements Concerning the Institution and its Courses of Instruction.* Houghton, Mich.; published by the School.

*Smooth Track. An Exposition of the Principles of Permanently Smooth Track, wherein is Shown the Feasibility of Welding the Rails.* By Philip Noonan. Lynchburg, Va.; published for the author.

*Cornell University Agricultural Experiment Station. Bulletin* 32, *October,* 1891. Ithaca, N. Y.; published by the University.

*Sixth Annual Report of the Commissioner of Labor,* 1890. *Cost of Production, Iron, Steel, Coal, etc.* Carroll D. Wright, Commissioner. Government Printing Office, Washington.

*The Census of Canada: Bulletin No.* 2. The Department of Agriculture, Ottawa, Canada.

## ABOUT BOOKS AND PERIODICALS.

WITH the number for October 31 the COMMERCIAL AND FINANCIAL CHRONICLE, of New York, issued a supplement of 184 pages, giving a list of State, county and city debts throughout the United States. This is, we believe, the only compendium of the kind ever attempted, and its great valne to bankers and investors is apparent. It gives in case of each State and municipality the population, resources and debt, with a brief statement showing rates of interest, dates of maturity of bonds and similar matters.

The first article in the OVERLAND MONTHLY for November is on Libraries and Librarians of the Pacific Coast. Other papers are on California Horse Farms; Administration of Law and Practical Education. There are several very entertaining stories and sketches, and also a bit of political history in the article on Gwin and Seward. This magazine is always readable, and is, moreover, valuable to all who want to know something of the Pacific Coast and its doings.

In the ECLECTIC MAGAZINE for November perhaps the most interesting articles are the second part of Mr. Murray's paper on Australia, from the *Contemporary Review,* and Professor Geffcken's on Russia, from the *New Review.* Other articles are given from the *National Review,* the *Westminster Review,* the *Saturday Review,* the *Fortnightly Review, Macmillan's,* the *Cornhill* and other English periodicals.

The fire in which its office was destroyed has not injured GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE, for the November number is an excellent one. Among the subjects treated are the New Jersey Geological Survey; a New Plan for Reaching the North Pole; the Peary Expedition to North Greenland; the Entrance to New York Harbor; the Ox-bows of the Mississippi, and the International Geological Congress. This magazine is by no means entirely technical, nor is it for teachers only; nearly all its articles are interesting to the general reader, and many of them contain valuable information not likely to be found elsewhere.

Among the papers in the POPULAR SCIENCE MONTHLY for December that will attract attention are those by P. D. Ross on Type Casting Machines, and on the rise of the Pottery Industry in the United States, by Edwin A. Barber. An extinct volcano in Connecticut is described by Professor W. M. Davis, and there are several other valuable articles.

A new catalogue recently issued by GOLDTHWAITE'S GEOGRAPHICAL EXCHANGE, No. 113 Nassau Street, New York, gives a long list of geographical appliances, maps, charts and works on geography. It would be hard to find a fuller or more complete list. The Exchange is now well established, and a visit will repay any one desiring to see a complete collection.

Among the books in preparation, by John Wiley & Sons, New York, is Part 3 of Professor Mansfield Merriman's treatise on ROOFS AND BRIDGES. This part treats of BRIDGE DESIGNS and will soon be issued.

The December number of SCRIBNER'S MAGAZINE is a holiday number and is chiefly devoted to stories and sketches. A series of articles on New Mexico is begun; they are handsomely illustrated.

The Smythe, Britton & Poore Company, Salt Lake City, Utah, has in press IRRIGATION CANALS AND OTHER IRRIGATION WORKS, by P. J. Flynn, C.E., which will be the most comprehensive work on this subject yet issued. Mr. Flynn has been a resident of Southern California for a number of years, and is considered an authority on this subject.

In the number of HARPER'S WEEKLY for October 24 there is a history of the Street Car, accompanied by many illustrations. The number for October 31 gives an account of the methods adopted in the high buildings of Chicago, with views of several of those buildings. In the number for November 8 there is a description of the cruiser *Baltimore*, with illustrations; articles on the Defenses of New York, and on Coal and Guns in the Navy; a paper on the Military Riding Schools of Germany, and a view and description of the new Pennsylvania Railroad Station in Jersey City.

In the November number of the ENGINEERING MAGAZINE Mr. Edward Atkinson writes of the lessons to be drawn from the Park Place Disaster. Other articles are on the World's Fair Buildings; the Perils of Coal Mining; Armored Warships; Chinese Silver Mining; the Manchester Ship Canal; Pumping Stations; Museum Building and Arrangement; and Building Laws.

The last number of the PROCEEDINGS of the United States Naval Institute is given up to the new Navy Instructions for Infantry and Artillery, which are here printed in full.

The ARENA for December has articles by Camille Flammarion, the French Astronomer, on Recent Discoveries in the Heavens. Among the other contributors are David A. Wells, Professor Funck-Brentano and Dr. Garland. This magazine retains always its independent and aggressive character, and is sure to have something well worth reading.

A very useful work is the ELECTRICAL TRADES DIRECTORY, which is issued each year by the London *Electrician*. The publishers wish to make it a complete list of electricians throughout the world, and will be much pleased to receive any information sent them. The book is published in January of each year.

The National Guard of California is the subject of the military article in OUTING or November. Other notable articles are Mr. Shinn's on Western Trappers, Mr. Page's on Fox Hunting in the Hudson Highlands, and Walter Camp's on Football; but there are several others which ought not to be passed over.

FOUR-WHEELED SWITCHING LOCOMOTIVE.

BUILT BY THE PITTSBURGH LOCOMOTIVE WORKS.

## A FOUR-WHEELED SWITCHING LOCOMOTIVE.

THE accompanying illustration, from a photograph, shows a switching engine recently built by the Pittsburgh Locomotive Works for use in the yards of Carnegie, Phipps & Company, in Pittsburgh—a compact and well-designed machine for the purposes for which it is intended. As will be seen from the engraving, it is a four-wheel engine of the ordinary type, with a saddle tank and with the entire weight upon the driving-wheels.

This engine has cylinders 14 in. in diameter, with 22-in. stroke; the driving-wheels are 43 in. in diameter, and are spaced 6 ft. apart between centers. With a total wheel base of only 6 ft. it will be seen that the engine will take very sharp curves, and is well adapted for the service usually found in a yard of this kind, which is rather trying.

The tank, which is carried over the boiler as noted, will hold 750 gallons of water, and the fuel-box has a capacity of 30 cubic feet. The total weight of the engine in working order, with tank and fuel-box full, is 63,000 lbs., making a weight of 15,750 lbs. per wheel.

This engine may be compared in general design with the switching engine of the Boston & Albany Railroad, which was illustrated in the November number of the JOURNAL. That engine was somewhat larger in size, but

weighed very little more than the one now shown, as it was provided with a separate tender.

## CAR-HEATER PATENTS.

*To the Editor of The Railroad and Engineering Journal:*

THE success of the appliances of the Consolidated Car-Heating Company has been so great that several manufacturers of more or less reputation have not hesitated to pirate our inventions. The Consolidated Company desires to warn railroad companies of these infringements, and thus to acquit itself of the obligation to give such notice. A flagrant violation of the Sewall coupler patents at the present time is especially noticed, where all the essential features are appropriated or closely imitated, while the unsuccessful attempt is made to evade the patents. The imitation is complicated and defective.

Another conspicuous instance is the placing of steam drums upon the cross-over pipes, which violates the well-protected invention of the Consolidated Company.

This Company will prosecute all such infringers of its patents and all those who use such infringements, while assuring railway companies of its indisposition to trouble them in such matters any more than is absolutely necessary for proper self-protection.

THE CONSOLIDATED CAR-HEATING COMPANY,
By WILLIAM G. RICE,
*Vice-President.*

ALBANY, N. Y., October 28, 1891.

## TRIAL OF THE "CINCINNATI."

THE new ferry-boat *Cincinnati*, the launch of which was described in the JOURNAL for June last, is now completed and ready for service, and was given a trial trip on November 7. A number of invited guests were there, including railroad and ferry officers, steamboat men and others. The boat made a short trip down the Bay, running up the East River for a short distance, and then up the Hudson as far as Yonkers, and the trip was much enjoyed by the Company's guests, as was also the very excellent lunch which was served on board.

The new ferry-boat, which is intended for the Pennsylvania Railroad line between New York and Jersey City, differs from the ordinary type of ferry-boat employed on the waters around New York in two respects. Instead of paddle-wheels she has two screws, one at each end, following, in this respect, the example set in the *Bergen* of the Hoboken Ferry. She has also an upper cabin, which is a new departure begun by the Pennsylvania Company. The fitting and furnishing of the boat is very handsome, though free from an excess of decoration.

The use of the upper deck increases the passenger space very largely; there was also a special reason for it in the new elevated station which the Company is now building in Jersey City. Passengers will be able to pass from this directly to the upper deck of the ferry-boat, and will not have to descend until they have reached the New York side and crossed West Street on the new bridge built by the Company.

The upper cabin is one spacious saloon, 87 ft. long and 38 ft. wide, and is on a level with these stations. The walls and ceilings are finished in delicate pink tints, relieved with aluminum leaf; the electric lights are placed on silvered brackets with opalescent shades around the sides, with two large iridescent electroliers opposite the landing of the stairs. The floor is handsomely carpeted. The mahogany seats are fitted with bent wood seat arms secured by silvered fittings. This cabin has a seating capacity for 166 persons. The stairs to the lower cabins are inclosed with leaded glass partitions of handsome design.

The two lower cabins are each 144 ft. long and 15 ft. wide. The adoption of the screw propeller gives an unobstructed view of the entire cabin, the handsome mahogany stairs being the grand central feature. These cabins are decorated in light pearl-gray tints, with papier-mache festoons on the frieze, and roughened canvas panels relieved with aluminum leaf, producing a most harmonious effect. The floors are entirely covered with mosaic tiling, and the central domes over the stairs leading to the upper saloon are lighted by leaded glass.

Mahogany seats, similar in design to those in the upper saloon, afford a seating capacity for 304 persons. The electric lights, which are arranged along the sides of the cabins, are of the same style and finish as those in the upper saloon, with the exception of around the stairways, where they are in clusters; the total number of lights in all the cabins is 112, making it one of the most brilliantly lighted boats in ferry service.

All the cabins are heated and ventilated by the Sturtevant system, by which the entire volume of air is renewed every five minutes. The supply of fresh air is drawn down an air duct 38 in. in diameter from above the upper deck, passed through a heater, which brings it up to the desired temperature, and delivered into the cabins near the ceilings at a pressure which forces the foul air through ventilators located under the seats, which are connected by ventilating ducts with registers opening into the team gangway. The temperature is governed by electro-thermostats which control the valves that regulate the hot and cold air supply at the heater, thereby maintaining a uniform temperature.

The joiner work was built by the firm of John E. Hoffmire & Sons from plans furnished by the architects, Furness, Evans & Company, of Philadelphia.

The hull is of iron, and was built by the Samuel L. Moore & Sons Company, at Elizabethport, N. J. It has five complete transverse and two longitudinal bulkheads extending between the collision bulkheads at either end, making in all 14 water-tight compartments. The deck beams are of iron and are covered with iron plates, and the housing around the engines amidships, which extends above the hurricane deck, is also of iron, making the boat proof against any fire which might originate around the boiler or in the hull. All the floors and platforms in the hull are of iron, no wood being used below decks except the insulating strips for the electric light wires. The principal dimensions are: Length over guards, 206 ft.; length of hull, 200 ft.; beam over guards, 65 ft.; beam of hull, 46ft.; depth from deck to keel, 17 ft.; draft, 10 ft. 10 in.; displacement, 890 tons.

The boat has two Williamson steering engines of a type originally designed for this Company, and first placed in service on the ferry-boat *Chicago* five years ago. These engines are placed in the hull almost directly under the pilot-house, which gives direct connection from the steering wheels to the engine and uniform leads for the tiller rope. There is attached to the bell gear a specially designed indicator connected with the engine-room, which shows the engineer from which pilot-house the signals are being given. This is arranged so that the handles connected with the indicator have to be raised before the pilot can ring the go-ahead bell, thus preventing any mistake on his part. There is also a dial in front of the pilot, showing the direction in which the engines are working, so that he will always know whether his signals are being answered promptly.

The motive power is furnished by two steeple compound engines, each having cylinders 18 in. and 36 in. in diameter and 26 in. stroke. These engines were designed and constructed at the Pennsylvania Railroad shops in Hoboken, and are fitted with Canfield's balanced piston valve. This valve was described and illustrated in the JOURNAL for August last. The valves are driven by an adaptation of the Marshall radial gear, and on the trial trip appeared to work with great smoothness and precision.

The shafts are coupled between the two engines so that in case of accident to either engine or line of shafting, they can be disconnected and used independently. The shaft extends the entire length of the boat, with sectional propeller wheels at each end; these wheels are 8 ft. 9 in. diameter and 13 ft. 6 in. pitch and work together in either direction. At 120 lbs. steam pressure and 106 revolutions a minute these engines have developed 1,016 indicated H.P., giving a speed of 14 miles per hour.

The condenser is detached from the main engines and has independent air and circulating pumps. A grease extractor is connected with the exhaust pipes from the

various engines to prevent the oil used in lubricating the cylinders passing with the feed water into the boilers. In a separate compartment adjoining the engine-room are situated the heating and ventilating apparatus, an incandescent electric light plant of 200 lights capacity of 16 candle power each, and also one of the steam-steering engines. In addition to this large electric light plant there is one of 35-light capacity in the engine-room, which is connected by a special circuit to all the signal lamps and to a number of the cabin lights to be used in case of accident to the larger plant.

In another compartment situated to the right of the engineer as he stands on the working platform is the boiler-room, in which are two tubular boilers built of steel; each boiler is 10 ft. in diameter, 10 ft. long, and has 49 square feet of grate surface and 1,750 square feet of heating surface. There is, in addition, a donkey boiler 42 in. diameter and 6 ft. 9 in. in height; a circulating apparatus is fitted in connection with this boiler by which a uniform temperature is maintained throughout the main boilers while steam is being raised. At the rear of the boilers is another compartment in which is located the other steam-steering engine and a fresh water tank.

## THE BORDENTOWN MONUMENT.

An interesting ceremony took place at Bordentown, N. J., on November 12, when the monument which the Pennsylvania Railroad recently completed there to commemorate the first laying of track in New Jersey was dedicated. The first track on the Camden & Amboy Railroad was laid near Bordentown in the summer of 1831, and the old locomotive *John Bull*, which had been purchased for the road in England by Mr. John Stevens, was put upon the track in that year. Two passenger cars were built, and the first passenger train over the new track, which was then completed somewhat less than a mile, was run on November 12, 1831, conveying the members of the New Jersey Legislature, who had been brought down from Trenton for the purpose of convincing them that the operation of a railroad by steam was feasible.

The monument was thus dedicated on the 60th anniversary of the running of the first train, which seemed a very fitting opportunity.

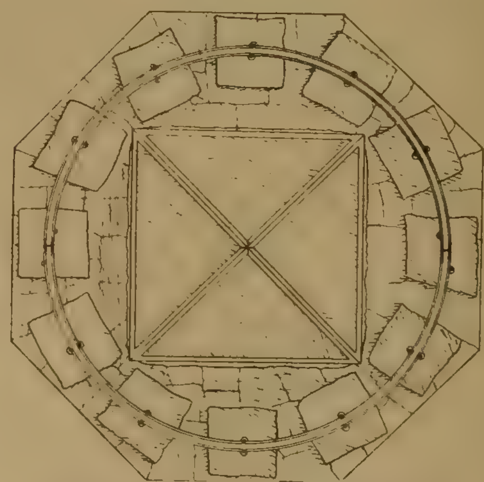
The erection of such a memorial was first suggested by Mr. J. Elfreth Watkins, who is now Curator of the Transportation Department of the National Museum at Washington, but was formerly employed on the Pennsylvania Railroad as a Civil Engineer. The plan was cordially approved and taken up by the officers of the company, and the monument was erected under the immediate supervision of Mr. J. T. Richards, the Assistant Chief Engineer.

The monument itself, the general form of which is shown in the accompanying sketch, consists of a block of rock-faced granite 5 ft. square and 6 ft. in height. On the face of this block, which is toward the track, is a bronze plate, on which is a representation of the first train, with an appropriate inscription, which is given below:

First movement by steam on a railroad in the State of New Jersey, November 12, 1831, by the original locomotive "John Bull," now deposited in the United States National Museum at Washington. The first piece of railroad track in New Jersey was laid by the Camden & Amboy Railroad Company between this point and the stone three thousand five hundred feet eastward in 1831.

It may be mentioned here that this first track was made of T rails of the form devised by Mr. John Stevens, and rolled for him in England, containing the germ of the form of rail which is now universally used in this country, and that these rails were laid upon blocks of stone bedded in the ground, the rails being held in place by spikes driven into wooden blocks inserted in holes in the stone.

The granite block composing the main part of the monument stands upon a pedestal some 3 ft. in height and octagonal in its general form. This is built of a number of the original stones used in place of ties, as described above, and upon the top of it and surrounding the base of the block is a ring composed of two of the old rails which had been preserved in the shops at Bordentown, joined together by some of the original joints, and resting upon a number of the old stone blocks which are placed at about the distance apart which they were usually placed in the



THE BORDENTOWN MONUMENT.

track. These relics were carefully gathered up—principally from the neighborhood of Bordentown and the old shops there—and are well authenticated, giving the monument peculiar interest. It may be noted here that as the Stevens rail was really the original of our present form of rail, so the clip joint which he used contains the germ of the modern fish-plate.

As noted in the inscription, the monument is placed at the western end of the track which was then laid. This track extended 3,500 ft. eastward, and the other end is marked by a plain granite post 5 ft. in height above the ground.

The ceremonies at the dedication of the monument were simple and impressive. A number of guests were brought by special train from Philadelphia, Trenton and other places, including, it was stated, one gentleman who rode upon the first train at the original trial trip in 1831. Mr. Isaac Dripps, who was afterward Master Mechanic of the Pennsylvania Railroad, was the engineer of the first train, and had been previously engaged in putting together the

old locomotive *John Bull* when it arrived from England. He is still alive and a resident of Philadelphia, but was, unfortunately, unable to come. A platform for the convenience of guests and speakers had been arranged alongside of the track, and General Stryker, Vice-President of the New Jersey Historical Society, was called upon to preside. With a few well-chosen words he introduced Mr. J. T. Richards, under whose charge, as above noted, the monument was built, who made a brief address, reciting the circumstances under which the monument was built, and transferring it to the custody of the United New Jersey Railroad & Canal Company. An address of acceptance on the part of that company by Mr. F. Wolcott Jackson, General Superintendent of the United Railroads of New Jersey Division, and then the main address of the day was made by Mr. Watkins. It was historical in its nature, giving an account of the organization of the Camden & Amboy Company, the difficulties which attended the first construction of the road, and its subsequent history, and referred at considerable length to the very important part taken by Mr. John Stevens and his sons in the building of the road and the designing of its substructure and rolling stock. It was exceedingly interesting in its nature, and we regret very much that space prevents us from reproducing it in full.

It is hoped that the good example thus set out at Bordentown will be followed elsewhere, and that memorials commemorating the prominent events of our railroad history may be erected elsewhere. The Bordentown monument is simple and tasteful and well adapted to the surroundings and circumstances, and it is solid enough to remain there to notify travelers for generations to come.

## LYNN HAVEN BAY AS A HARBOR OF REFUGE.

By Lieutenant Henry H. Barroll, U. S. N.

The geographical position of Cape Henry and its vicinity makes it highly desirable that there should here be constructed a harbor to allow refuge in threatening or in stormy weather to the shipping that may be either entering or departing from Chesapeake Bay, as well as to those vessels passing up and down this portion of the coast.

Cape Hatteras may well be considered the most dangerous point on the Atlantic coast of the United States. Several causes combine to make this locality a dangerous one to navigators.

From Cape Henry, the lower of the two points marking the entrance to Chesapeake Bay, the coast-line runs about south-southeast, for a distance of 100 miles, to Cape Hatteras. From Hatteras southward, as far as Fernandina, a distance of some 400 miles, the general trend of the coast is about southwest.

The line of direction of this southern portion of the coast has also determined the direction of the Gulf Stream. The shore-line has been much worn by the action of the waves, forming three marked indentations, known as Long, Onslow and Raleigh Bays, and just at the northern extremity of the last-mentioned indentation, and at the apex of the angle formed by the two lines of coast, is Cape Hatteras, a low, sandy point, scarcely visible even under most favorable conditions of weather, at a distance of six or eight miles, while dangerous and constantly changing shoals of hard sand stretch out to seaward fully 10 miles from the shore-line.

Here the Gulf Stream, transporting immense volumes of tropically heated water, and which is constantly communicating its warmth to the air above its surface, meets the cold Arctic or Counter Current, which flows along the upper Atlantic coast, and also encounters the cold air-walls, or atmospheric waves, sweeping from our northwest territory.

In recent years careful surveys, deep-sea soundings and temperatures taken with self-registering thermometers have accurately defined the limits of this great ocean current. At Hatteras the warm tropic river, flowing through its bed of colder waters, is breasted off to the northeast, but not until it has forced itself to within less than 40 miles of the coast; while in the latitude of the Delaware capes the outer cold wall forming its western bank is more than 300 miles further to the eastward.

It is almost impossible to realize the magnitude of this immense stream—one of the greatest arteries in that wonderful system of the ocean's circulation. At Cape Hatteras it has a width of about 100 miles and a depth of 600 ft., and flows at the rate of from 35 to 50 miles a day. These figures serve to illustrate the tremendous force that is constantly being brought to bear day and night against the apparently insignificant sand point, which, nevertheless, steadily deflects and determines the course of this mighty river of the sea.

The violent revolving storms which we now denominate *cyclones*, and which have their origin in meteorological disturbances occurring to the eastward of or in the vicinity of Barbados, sweep northward, the center of the storm generally describing a parabolic curve in its passage northward.

These gales are most liable to be disastrous to shipping when the vessel's position with regard to the storm's center is not accurately known. Modern science has demonstrated that these meteors can be made of service to navigation rather than the reverse, provided that the navigator carefully avoids what is now well known to be the dangerous semicircle of the storm. But unfortunately the storm's center, moving northward, as before stated, approximately on a parabolic curve, has a tendency to recurve or to pass from the northwest arm to the northeast arm of the parabola, returning, as it were, with redoubled force upon vessels that were previous to this well clear of the dangerous semicircle.

The majority of these tropical gales recurve between the limits of latitude 23° north and latitude 33° north. Cape Hatteras lies in about 35° north, and therefore during the progress of a cyclone vessels in the vicinity of this cape are always subjected to the dangerous sudden shifting in direction of the wind, and to the confused, irregular sea that such recurving produces.

Another feature that complicates the passage of Cape Hatteras, especially to vessels coming from the southward or the eastward, is the fact that here, owing to the extremely irregular profile of the ocean's bottom, the sailor, when approaching the shore, can derive little knowledge from the use of the lead. Coasting vessels can, to a certain extent, be assisted by frequent soundings, when rounding Hatteras from the northward, but when approaching from seaward—say from a direction southeast of the cape—the lead is practically useless.

Vessels arriving upon that stretch of our coast lying between Cape Henry and New York will find that the depth of water shoals with comparative regularity—an important factor in navigation. Eastward of Cape Henry the 50-fathom curve will be found at a distance of 65 miles from shore, and eastward of Barnegat the same depth is found at 75 miles, while it is impossible to get within 80 miles of Sandy Hook lightship before having first gotten into less than 50 fathoms.

On the other hand, at Cape Hatteras the 50-fathom curve approaches to within 15 miles of the shore-line and to within 7 miles of the Outer Diamond, a dangerous shoal, over which there are, in some places, only 5 ft. and 8 ft. of water. Ten miles from Cape Hatteras there are shoal spots having only 18 and 20 ft. of water. At a distance of 20 miles there is 100 fathoms, and at 30 miles a depth of 1,650 fathoms is reached. The irregular nature of the bottom here is well illustrated by the accompanying map, which is a reproduction of a part of a United States Coast Survey chart.

These causes combine to produce at Cape Hatteras most disastrous effects upon shipping either during the greater tropical gales or in the lesser and more localized disturbances, which can here always cause great damage to vessels subjected to their influences.

Thus early in life does the seafaring man learn to have a wholesome respect for Old Hatteras, whose white, hard sand beach represents the tombstone of many a gallant mariner.

"If the Bermudas let you pass,
Then look out for Hatteras."

This distich is well known to the mariner. It represents to him the experience of ages, extending from the obliteration of the prosperous and happy little Jamaican city of Savana la Mar, in 1780, or the scattering and wrecking of Rodney's fleet in 1782, when 90 vessels were lost and 3,000 seamen drowned, to the more recent March blizzard of 1888, or the recent wholesale destruction wrought upon the island of Martinique by the cyclone of August, 1891.

In order to guard against the many dangers that in this locality beset the sailor's pathway, the United States Government has ever been striving to place and keep here good, reliable aids to navigation.

For years attempts were made to keep the shoals marked by large iron buoys; but although these were moored with the heaviest class of chains and anchors, they were constantly being torn away by the powerful sea that here breaks during gales of winds. Along the stretch of beach extending from Hatteras to Cape Henry are 21 life-saving stations, spaced at distances of only about five miles from each other. The main light at Cape Hatteras is shown from a huge tower 191 ft. above the level of the sea. It is a powerful, first-order light, and is visible to a distance of 20 miles. Another smaller lighthouse, built close to the extreme point of the cape, throws another gleam over the outlying shoals, and in addition there is now under course of construction on the Outer Diamond an enormous lighthouse, whose cost is to be $500,000.

Surely the United States cannot be accused of neglecting to advance the interests of her commerce when we see her spend half a million dollars in order that the faint glimmering speck which guides the mariner by night shall be shown from a spot some eight or nine miles further to the seaward of this treacherous sand point.

Yet notwithstanding all the care thus taken and all the money thus spent, the mariner can never depend upon the assistance here provided for him. He may even be approaching the coast in broad daylight, with favoring wind and with perfectly clear weather, when a chilly wave of air from the northwest meets the warmer atmosphere above the Gulf Stream, and his vessel is soon enveloped in a dense fog-bank, and he must continue his way in danger and uncertainty.

To vessels that have encountered damage at sea, it is of utmost importance that there may be close at hand some port where repairs can be made. In the history of the sea too often has it been the case that after having successfully combated the fury of the fiercest gale, a noble ship has been forced to succumb to a lesser storm, brought to bear upon a broken, dismantled vessel, whose weary crew, after their hard-earned victory, were unable to cope with the lesser foe.

Owing to the direction in which the Gulf Stream flows, vessels that have been disabled anywhere in the neighborhood of this locality find themselves, in "clearing-up weather," to be to the northward of Cape Hatteras; and, therefore, it is very desirable to have immediately north of this point some convenient and well-sheltered port for which disabled vessels may steer.

Vessels leaving Boston, New York and other northern ports, and bound southward, can always find safe anchorage behind the Delaware Breakwater from gales of any nature, and can venture forth and pursue their voyage as soon as the position of the storm's center indicates that their course no longer lies through its dangerous semicircle.

But after leaving Delaware Breakwater the next protection for vessels of draft of 8 ft. and over is only to be found in some sheltered port in Chesapeake Bay. Lynn Haven, an open roadstead just to the westward of Cape Henry, furnishes to vessels protection against southerly winds; but owing to the exposed nature of this roadstead to the northward, it is at present but a doubtful shelter, since in the case of a revolving storm the shifting in direction of the wind would leave the vessel on a lee shore with a sweep of the entire Chesapeake Bay to roll in a sea of such magnitude that she could not safely ride at anchor before it.

The only safe course in such a case would be to continue to Hampton Roads, passing through the narrow gateway at Fort Monroe, and anchor where there is shelter from all directions. But this necessitates the sailing of a further distance of some 20 miles—a track which the vessel must also retrace in order to get once more upon the sailing line to her destination. Freights are low, competition is sharp, and owners of vessels are exacting, and therefore the master, even with all indications of an approaching gale, will sometimes hesitate to add to the security of his vessel by sailing this additional 40 miles.

If his vessel is bound southward he has probably had comparatively fair weather since leaving the vicinity of the Delaware Breakwater, 100 miles to the northward. He argues with himself that it is only an equal distance further south to round Cape Hatteras; and he generally decides to "chance it on the course to the port" rather than to make a harbor at the expense of so much time and trouble.

Perhaps all goes well; and after two or three days' buffeting he weathers the gale, and saves on his voyage the 40 extra miles to Hampton Roads and back. Perhaps all does not go well; and then the bones of his staunch vessel go to add to the litter on the wreck-strewn beach from Hatteras to Nag's Head.

In some cases the master makes a compromise, and takes an anchorage in the open roadstead at Lynn Haven, trusting to his ability to get under way at the first sign of a change in the direction of the wind; but this, although sometimes made necessary, owing to stress of circumstances, is not a wise proceeding.

These considerations illustrate how much the immense commerce of Chesapeake Bay and its numerous tributary rivers would be enhanced by the building of a breakwater here, just inside the entrance to the bay. There would then be here provided a safe and convenient harbor only 100 miles distant from Cape Hatteras, and also at the final point of leaving the more sheltered Chesapeake Bay for the great ocean itself.

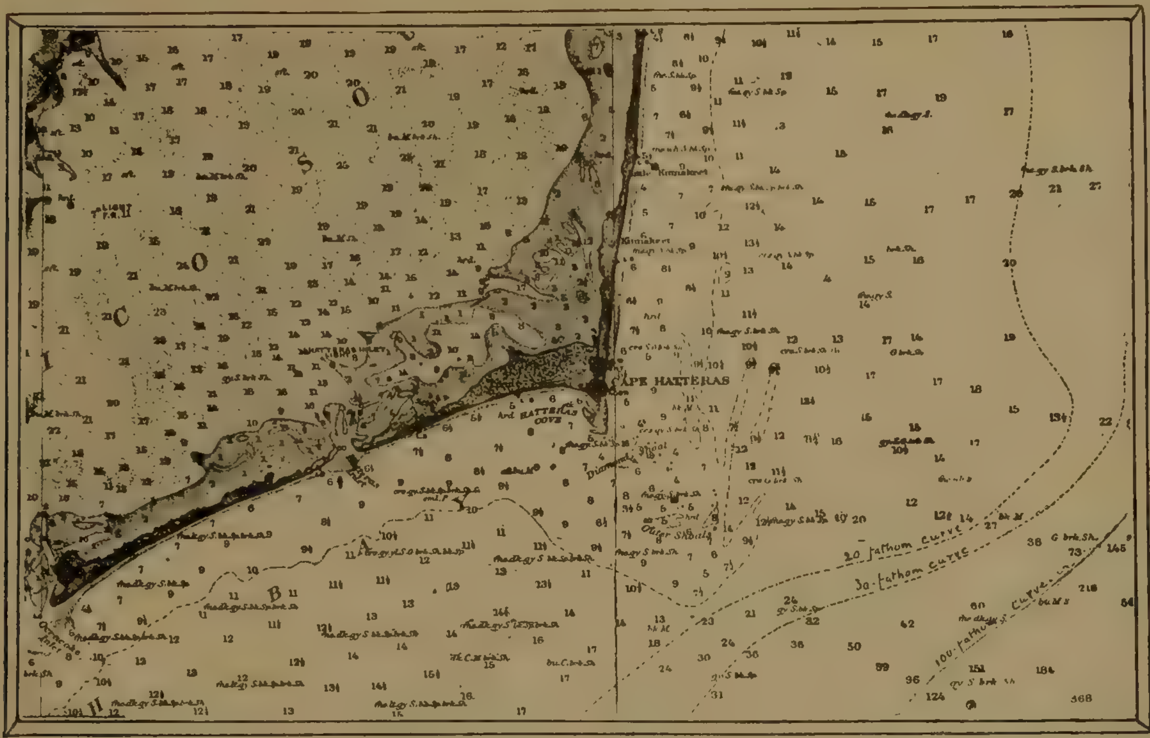
Within the last few years there has been established between Chesapeake Bay and northern ports a system of transportation by barges, several of which will proceed to sea in tow of a single tug. This class of transportation has now assumed such great proportions that its necessities should not be overlooked, and a secure harbor just inside of Cape Henry would be of vital importance to this class of vessels.

In many cases vessels would use this harbor in passing, merely coming here to report for orders or to send information to their owners. At Cape Henry is located a sea coast signal and telegraph station, and vessels could thus report their arrival, and receive instructions where to proceed. Little time would be lost by even passing vessels, were they to make a harbor here in anticipation of heavy weather; while perhaps to a sailing vessel the time required to reach the secure anchorage in Hampton Roads would be represented by the better portion of a day.

It would be difficult to estimate the saving of life and property by the establishment of a harbor of refuge at this place. Thousands of lives and millions of dollars' worth of property are daily passing through this great artery of our commerce. It has been estimated that that portion of the commerce that passes through Hampton Roads is equal to that which ascends to the city of Baltimore. To this must be added the traffic of the numerous tributary streams, the York, Rappahannock, Potomac, Patapsco, etc., their shores lined with prosperous cities and thriving towns.

The late wonderful development of the South under the last few years of heavy crops and a great influx of Northern capital seeking investment has been nowhere more marked than here at the southern gateway to the ocean. Urged on by the prosperity of the territory to the south and west, Virginia's seaports, all of which are situated on Chesapeake Bay, have been taxed to their utmost to receive and trans-ship the produce that is being constantly crowded here to meet water transportation.

The great coal mines of the western part of Virginia, pouring their steady stream of rich bituminous coal into the grand harbor of Hampton Roads, constantly demand additional wharves and piers for the handling of their ever-increasing output. In 1886 the coal shipments from one of these piers—Lambert's Point—aggregated 504,000 tons,




CAPE HATTERAS AND VICINITY.


CAPE HENRY AND LYNN HAVEN ROADS.

FROM COAST SURVEY CHART NO. 131.

In 1890 the shipments aggregated 1,250,000 tons. In 1878 the estimate made of the value of the oyster trade of Norfolk was $350,000 ; in 1890 this trade gave employment to 18,864 persons, and was valued at $3,124,444.

The waters of Chesapeake Bay teem with every variety of fish, and its shores are under almost close cultivation in the raising of vegetables for northern markets. Each day thousands of craft, from the ocean steamer to the diminutive oyster pungy, are cleaving its waters in the pursuit of a livelihood, and the extent to which this grand body of water contributes to the support of the surrounding maritime community is inestimable.

To all these would a harbor here at the entrance to the great bay be of advantage. A list of the vessels that have in the last few years gone ashore on this portion of the coast, and yet inside of the protection as now afforded by the capes, shows the amount of havoc that is each year wrought on account of a want of sufficient protection at this place.

VESSELS REPORTED AS ASHORE, OR SUNK, BETWEEN CAPE HENRY AND SEWALL POINT, VA.

February 8, 1886 : A two-masted schooner sunk W. N. W. of Cape Henry ; schooner *Anthea Godfrey* sunk in Lynn Haven Bay. (Afterward blown up by U. S. engineers.)

December 9, 1886 : A tug-boat ashore on Cape Henry.

November 2, 1887 : Schooner *Wallace J. Boyd* ashore on Sewall Point ; American schooner *William T. Phelps* ashore on Willoughby Spit ; American schooner *Carrie Holmes* ashore at Cape Henry ; American schooner *Mary D. Cranmer* ashore at Cape Henry ; British bark *Alabama* ashore at Ocean View ; American schooner *Elias Moore* ashore 3 miles east of Ocean View ; brig. (nationality unknown) ashore at same place ; British bark *Harvester* ashore at the same place.

December 30, 1887 : American schooner *Catharine W. May* sunk in 10 fathoms 12¾ miles W. ½ N. of Cape Henry.

January 2, 1888 : Steam yacht *Mohican* ashore on Willoughby Spit.

February 16, 1888 : American schooner *Maud Seward* ashore on Willoughby Flats.

February 27, 1888 : American schooner *Alfred E. Smyrk* sunk while at anchor two miles east of Thimble Light.

March 13, 1888 : A large three-masted schooner sunk in 5½ fathoms south of Thimble Light, a few miles east of Fort Monroe.

March 18, 1889 : American bark *E. L. Pettingill*, just returned from Asia, sunk a few miles northwest of Cape Henry, and all on board perished. (This vessel had for several years weathered gales in all parts of the world, only to founder at her anchors at this home port.)

April 9, 1889 : American schooner *Charles P. Sinnickson* totally wrecked at Ocean View.

October 25, 1889 : *General Harrison*, rig unknown, ashore 3 miles north and west of Cape Henry ; American schooner *Rover* ashore 3 miles east of Ocean View.

It would be unnecessary to continue the list, which is constantly being added to in a more or less rapid degree according to the season of the year. The most noticeable feature of the above list is the disaster following the cyclone of October 13 to October 23, 1887. In later years vessel captains have become more wary of trusting to the insufficient shelter afforded by the present roadstead of Lynn Haven.

The cyclone of October 13–23 is plotted as follows :

October 13, about 300 miles south of Havana.
October 14, center about 50 miles north of Campeche.
October 17, center 100 miles south of Galveston.
October 19, center 50 miles south of Mobile.
October 20, center about 75 miles west of Hatteras.
October 21, center about 75 miles east of Boston.
October 23, center about 50 miles north of St. Johns, Newfoundland.

There was plenty of time for the approach of this storm to have been signaled to vessels passing along our coast, and no doubt this was done at every signal station along the coast. Probably hundreds of vessels remained in harbor owing to the fact of its approach having been signaled, yet those vessels of the above list mentioned under the date of November 2 were undoubtedly attempting to get an anchorage inside of Hampton Roads, or had taken anchorage at Lynn Haven, and upon the approach of the storm's center in this locality were driven ashore ; and a week later this portion of the coast is shown to be literally lined with stranded vessels.

A record of disaster such as the above speaks with no uncertain voice. Of all classes of investment, that of shipping represents probably the least wealth in proportion to the number of people who are its owners. Each small schooner is usually owned in part by the captain, and in some cases each member of the crew has an interest in the profits of the vessel. So, in such cases as that of November 2, 1887, when the report goes forth to Washington of the eight vessels whose wrecks lined this stretch of coast, it represents not only the loss or detention of these vessels, but probably also the loss of many a bread-winner for those at home waiting with expectant eyes for the sail that is never to return. Not only the loss to the crew of their place, their occupation, their clothing, but also their share in the vessel's profits ; while those at home are beggared as much as are the stout men who have struggled through the breakers and gained the beach.

The records of the Life-saving Service show that for the two years ending June 30, 1891, there occurred casualties to no less than 160 vessels between Cape Fear and Cape Henlopen. The estimated value of these vessels and the cargoes they carried was $3,404,485, of which the estimated sum lost was $1,146,890. There were aboard these vessels 1,116 persons, and it is gratifying to note that, owing to the efficiency of our Life-saving Service, only 51 of these lives were lost.

From these figures it would appear that there are every year risked on this dangerous coast a regiment of lives and nearly $3,500,000 of property, and while the exertions of the Life-saving Service reduced the loss of lives to less than 5 per cent. of those risked, such fortune does not befall the ships and their cargoes, since of this property more than 33 per cent. is lost.

With regard to the feasibility of constructing a breakwater here, it is well to first examine the locality, and see what Nature has already done in that respect, and then strive to assist rather than retard her efforts.

By reference to the plate on the first page, a reproduction of a part of United States Coast Survey Chart No. 131, it will be seen that there is a well-defined channel lying close along the shore, almost as far to the westward as the hotel at Ocean View. To the northward of this littoral channel, and separating it from the Main Ship Channel into Hampton Roads, are a series of shoal banks making eastward from Willoughby Banks. Just to the northward of Lynn Haven Inlet, the opening to the river of that name, and lying about 1¾ miles off shore, is the last portion of this series of shoals—a small bank having only 3¾ fathoms, while between this and the shore will be found as much as 5 fathoms of water. This clearly shows that the tendency of the littoral currents caused by the ebb and flow of the tide is to cut out the channel at the expense of piling up sand on the banks. This small shoal should be taken as the nucleus of a breakwater, and with a clear approach at each end there would be no difficulty experienced in keeping at all times a channel of at least 20 ft. at lowest stage of the tide. The dotted line on the map shows approximately the location for the breakwater.

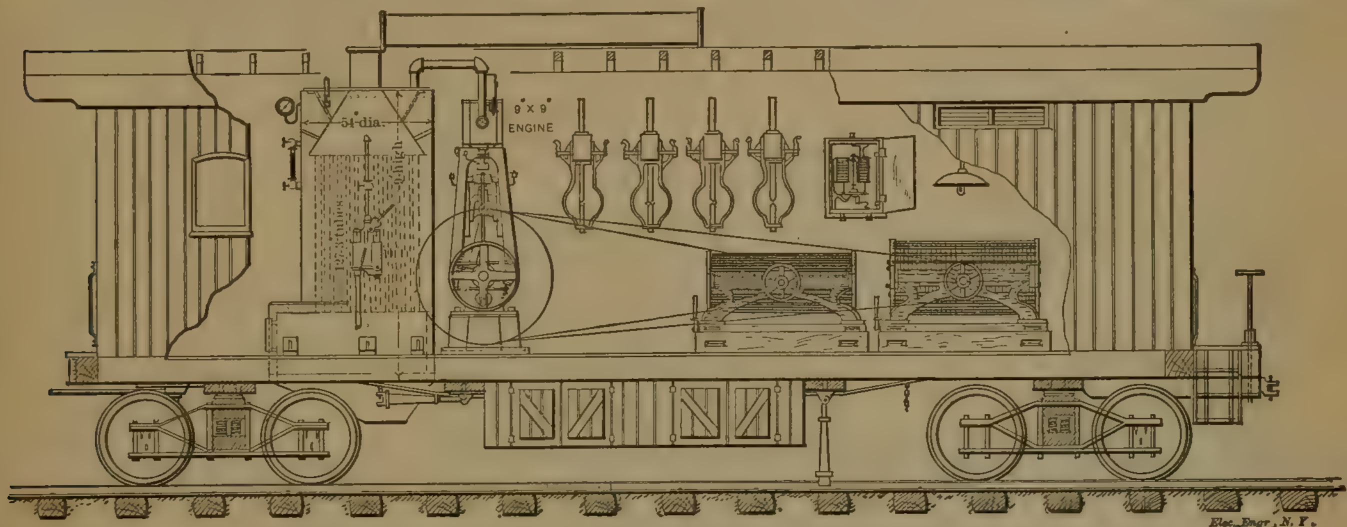
The question of expense can easily be estimated, since it only consists in calculating the cost of the transportation and depositing of a sufficient amount of stone to form here a reef of large enough size to break the obnoxious seas from the northward. There would be no need of an ice-breaker, as in the case of the Delaware Breakwater ; and with each end of the breakwater lying in the general direction of the flow of the tidal currents, there would always be a good depth of water in the harbor.

With the experience of the Delaware Breakwater our engineers would probably be able to greatly reduce the cost of a similar protection here at the mouth of the Chesapeake Bay ; but even at a cost equal to that of the Delaware Harbor of Refuge, such expenditure would be well repaid. A government that can afford, as at Hatteras, to expend a half million dollars to add to the safety of its sailors, can well afford also to expend an equal amount for a harbor of refuge at this, the point of all others on the Atlantic coast where such protection is needed.

## A PORTABLE ELECTRIC LIGHTING PLANT.

THE accompanying illustration, for which we are indebted to the *Electrical Engineer*, shows an electric lighting plant in use on the Cumberland Valley Railroad. It is described in the *Engineer* by Mr. C. S. Hull as follows:

Having recently read of portable electric lighting as being a new scheme, I send you prints of a portable electric light plant designed and built by me for the Cumberland Valley Railroad, at the Chambersburg, Pa., shops, in 1883, and which has been in constant use up to date. The accompanying illustration explains the construction.




ELECTRIC LIGHT CAR FOR THE CUMBERLAND VALLEY RAILROAD.

We use this plant for lighting at wrecks, and rent it for picnics, camp-meetings and often for public lighting. The capacity of the plant is forty 2,000-candle-power and two 65-candle-power incandescent series lamps.

This plant consists of a fifteen 2,000-candle-power lamp dynamo, built by the Thomson-Houston Electric Company, 1880, purchased by our Company in 1882; a twenty-five 2,000-candle-power lamp dynamo, spherical type, purchased in 1886, operated by a 35 H.P. vertical automatic engine and a 40 H.P. vertical submerged flue boiler, built by the Taylor Manufacturing Company, Chambersburg, Pa. The plant has given entire satisfaction.

## MR. EDISON'S RAILROAD INVENTIONS.

(From the *Electrical Engineer.*)

OUR columns contain this week the bitter protest of a correspondent against the various reports that have appeared in the newspapers with regard to some new work of Mr. Edison in electric railroads. It is a matter of fact that, as there stated, the effect of these newspaper articles has been to put a check upon immediate investment in existing methods of electric railroad work, and for that reason they are to be deplored. But it is hardly fair to hold Mr. Edison responsible for the exaggerations and bulls crowded into these reports. Some day the newspapers will perhaps employ skilled men on their technical work as they now do on that which relates to music and the drama; but in the mean time we must be thankful things are no worse. If this talk arrests development, the Edison General Company will suffer with the rest, and even his worst enemies will credit Mr. Edison with shrewdness enough to see that palpable and obvious fact. There is, however, offset to the harm done. It is a great thing to have the whole country talking and thinking about electric railroads, for in due course misinformation will be corrected and the truth shine clear. Having tried ourselves for ten years past to engage public attention on electric railroad work, we are glad to see that the subject is now ripe for a nation's thought. If Mr. Edison, too, can add to existing methods one by which low voltage may be used, it is cause for general congratulation, even though to many of us lowering voltage looks like a decided step backward. We are all gainers by every extension of the field, and in the long run not a cent less will be spent in railroad investment. Moreover, there is no evidence that existing methods or apparatus will be wiped out, even by the most revolutionary invention. Each new invention simply restricts other ways of reaching results to their strictly legitimate sphere of greatest profit and benefit; and as far as electrical plant is concerned, the depreciation is generally so slight that, even in spite of the great advances made, apparatus is still running with satisfaction that belongs to the very early stages of the art. In a word, we do not see the slightest reason why any single railroad project entered upon or even broached should not be carried to a conclusion. When Mr. Edison puts his plan on the market it will be time enough to discuss its actual effect.

## THE UNITED STATES NAVY.

THE last report of the Chief of Ordnance recommends the construction of an experimental breech-loading rifle of 16-in. caliber. The forgings can now be obtained in this country and the gun can be finished in the shops at the Washington Navy Yard.

### THE MONITOR "MIANTONOMOH."

This ship may be said to be really the first battle-ship of the Navy to go into commission. She was ordered to be ready for service at the New York Navy Yard last month, although some work still remains to be done upon her.

The *Miantonomoh* was originally one of the double-turreted monitors completed about the close of the War. She was put in commission in 1866, having then an armament of four 15-in. smooth-bore guns, and soon after made a cruise to Europe. From that time she was in service but little until 1885, when it was decided to rebuild these vessels, with iron hulls and other improvements.

The ship is now of iron throughout, the hull being divided into 87 water-tight compartments. She is of the original low freeboard monitor type, the deck being only 25 in. above water; the sides have 7-in. armor. The chief dimensions are: Length, 262 ft.; breadth, 55 ft. 2 in.; mean draft, 14 ft.; displacement, 3,820 tons.

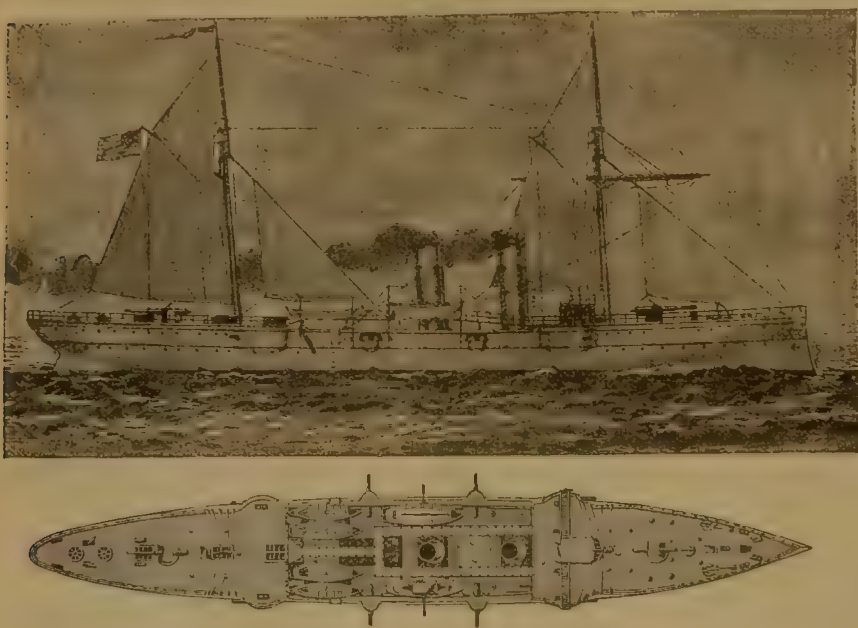
The ship has twin screws, each screw being driven by a compound engine, with cylinders 32 in., 40 in. and 40 in. in diameter and 42 in. stroke. Steam is furnished by four boilers, carrying a working pressure of 80 lbs. She is not expected to make over 14 knots an hour.

The *Miantonomoh* carries four 10-in. breech-loading rifles, the first of the new guns of this caliber in service. Two of these guns are in each turret, on hydraulic mounts. The turrets are 24 ft. 6 in. in diameter, and are armored with steel plates $11\frac{1}{2}$ in. thick. In addition to the large guns there are four 6-pdr. Hotchkiss guns on deck and two revolving cannon in the tops of the military masts with which the ship is provided.

### LAUNCH OF THE "DETROIT."

The new cruiser *Detroit* was launched from the yard of the Columbian Iron Works in Baltimore, October 28. She is an unarmored steel cruiser 257 ft. in length and 37 ft. beam, and will have a mean draft of 14 ft. 6 in. The machinery is covered by a protective deck varying from $\frac{3}{8}$ in. to $\frac{7}{8}$ in. in thickness, and is further protected by a coffer-dam filled with cellulose and by the arrangement of the coal bunkers. Her displacement with a normal load is 2,000 tons.

The ship has twin screws, each driven by a triple-expansion engine of the vertical inverted type, having cylinders $26\frac{1}{2}$ in., 39 in. and 63 in. in diameter and 26 in. stroke.



THE NEW CRUISER "DETROIT" FOR THE UNITED STATES NAVY.

The engines are expected to develop 5,400 H.P., with 160 lbs. boiler pressure and running at 185 revolutions. There are three double-ended boilers 11 ft. 8 in. in diameter and 18 ft. 8 in. long, and two single-ended boilers 11 ft. 8 in. in diameter and 9 ft. 2 in. long. The forced draft is on the closed ash-pit system.

The coal bunkers will hold 200 tons, and extra bunkers are provided so that 435 tons can be carried. With the latter supply the cruising range is 8,950 knots at a 10-knot speed. The contract speed with full power is 17 knots an hour.

The armament carried will consist of two 6-in. and eight 4-in. rapid-fire guns. The secondary battery will include four 6-pdr. and four 3-pdr. rapid-fire guns and two 37 mm. (1.46-in.) revolving cannon. There will also be six torpedo-tubes.

The *Detroit* has two masts and will have a fore-and-aft rig. The general appearance of the ship is shown by the accompanying sketch, which is taken from the report of the Bureau of Construction.

Cruiser No. 9, which is not yet named, is nearly ready for launching at the same yard. There are altogether three of these 2,000-ton cruisers under construction, and they are expected to be very useful and handy vessels for cruising work. The armament is a heavy one for their size.

## NOTES ON COMBUSTION.

BY C. CHOMIENNE, ENGINEER.

(*Continued from page* 501.)

### POSSIBLE ECONOMIES IN COMBUSTION.

WE have already seen that the loss by incomplete combustion of gases is still from 5 to 6 per cent. of the total heat, even under good conditions, or about 10 per cent. of the heat actually utilized. If, then, we wish to do away with this loss, and at the same time to reduce the loss by the chimney, by avoiding an excess of air, we can easily obtain a saving of 10 per cent., and with poor firemen this economy might reach and even exceed 20 per cent. The great importance of this saving, when the enormous quantity of coal burned in boilers is considered, has led to a great many attempts to obtain it.

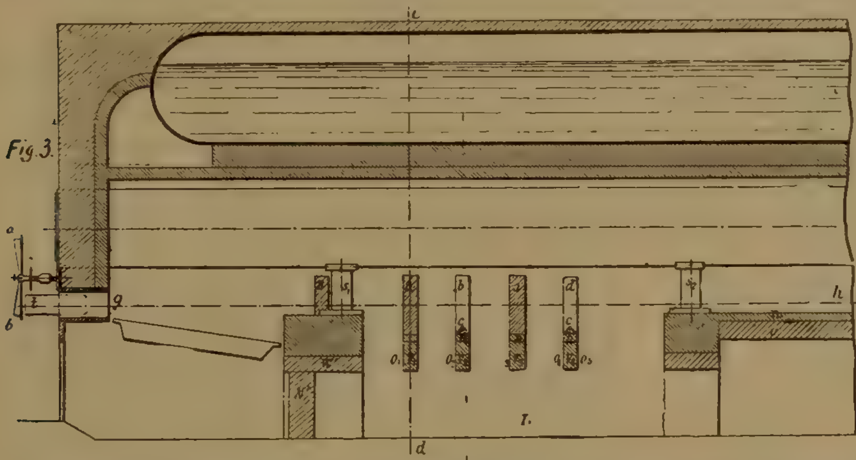
As one of the latest instances of these, we give here the apparatus of M. Criner, which is shown in figs. 3, 4, 5, 6, 7 and 8. This apparatus seems to have succeeded very well in uniting the merits of simplicity, low cost and ease in management. It has been tried by a number of engineers, including the Chief Engineers of several of the French District Associations of boiler-owners, and it has been considered well to give a description below of this apparatus, as applied to a boiler with external fire-box. It is with this class of boilers that it is most easily applied.

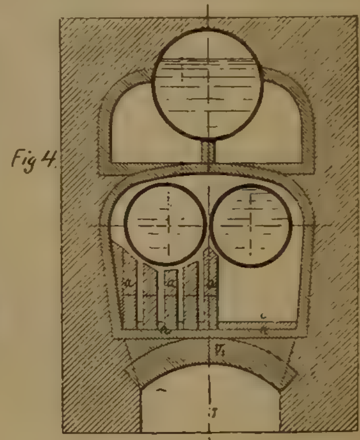
The Criner fire-box is composed of a distributor of air over the grate, and of an arrangement for mixing the gases as they leave the fire-box.

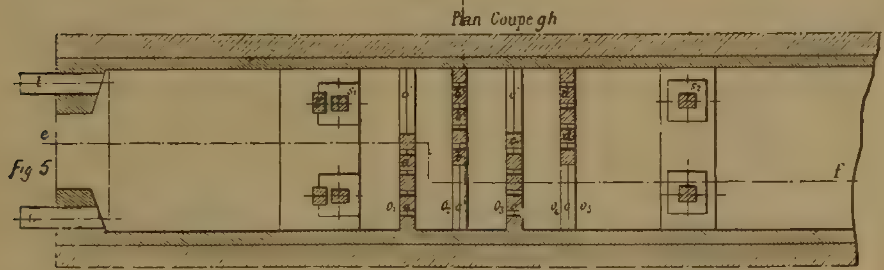
The air distributor is shown in figs. 3, 5 and 6, and on a larger scale in figs. 7 and 8; fig. 3 is a longitudinal section; fig. 4 a cross-section on the line *c d*, and fig. 5 a horizontal section on the line *g h*.

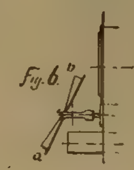
The distributing apparatus is composed of a tube *t*, figs. 3, 5 and 8, which passes into the fire-box, one end being open to the air, while the other opens in the fire-box above the grate. In this tube is a valve or damper, by which the quantity of air introduced in a given time can be regulated. There is also a sand-box *S*, figs. 7 and 8, resembling an hour-glass, which has two compartments *a b*, and which contains very dry sand. An arm *V* extends horizontally into the hole which connects these two compartments, and thus serves to increase or diminish the speed with which the sand passes from one to another. This sand-box has two distinct movements; it can oscillate around the points of suspension *x x*, and the support *y y*, which forms the socket, permits it also to rotate. This support is fixed in front of the fire-box in such a way that the opening of the tube *t* will be completely closed by the sand-box when it is vertical. The sand is then in the lower compartment. When the tube *t* should be opened and give free access to the air, it is sufficient to turn the sand-box 180° around the support *y y*. In this way the compartment *b* which was below is raised above, and the weight of sand which it contains causes the sand-box to oscillate around its axis *x x*, forcing it to take the inclined position *a' b'*. It thus leaves the mouth of the tube *t* open until the sand has run down in a sufficient quantity to make it resume the vertical position *b'* coming to *a* and *a'* to *b*. Thus the damper of the tube *t* serves to regulate the quantity of air introduced, while the arm *V* serves to regulate the length of this introduction. Two of these apparatus are employed for each generator.

The arrangement for mixing up the gases, which is intended to mix them completely before they reach the point where the flame is extinguished, is usually composed of a series of bars or columns *a*, *b*, *c*, *d*, figs. 3 and 5, of fire-brick, or some other refractory substance, placed in rows behind the bridge. Under the influence of the draft the gases are obliged to pass around these obstacles in their way. There is, then, a sharp agitation which brings rapidly in contact all the elements which can combine at a very high temperature, in such a way that combustion is hastened, and will end before the point of extinction is reached. These columns being in the hottest part of the fire are carried to a red heat, and then serve by their own temperature to light the gases which have become cooled in their passage from the fire-box, when fresh coal is thrown upon the grate. Moreover, becoming heated by their contact with the currents of burning gases, they will give out by radiation a portion of this heat to the boiler under which they are placed. It will be seen that, thanks to the air distributor, which permits us to give all the air required at the moment when the coal is distilled, we can have less air in excess during the period which follows the distillation, either by partially closing the register or by increasing the thickness of the layer of coal.

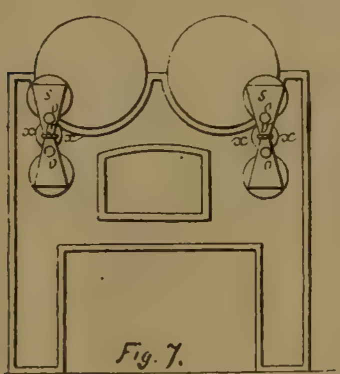


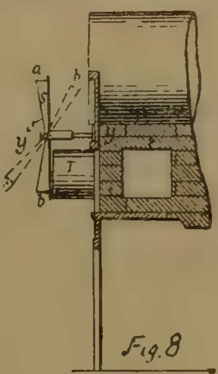




THE CRINER FIRE-BOX.




One point which is somewhat surprising at first sight is an increase in power which this system gives to boilers, and this has brought it into much favor even among mining companies, where the refuse coal which is usually burned has very little value. If what we have said above is carefully considered, however, it will be seen that there are three reasons for this:

1. The gases leaving the mixing apparatus are much hotter and the boiler will absorb a greater amount of heat.

2. The columns or bars act by taking up a portion of the heat of the gases, which they radiate to the boiler.

3. Combustion with less excess of air permits us to burn more carbon with the same total quantity of air introduced through the grate.

These Criner fire-boxes are also very good smoke-consumers. The Dieuze Salt Works, which have 13 of these fire-boxes and use a coal of mixed quality, report an increase of 29 per cent. in power with a saving of 12 per cent. in fuel. At the mines of St. Etienne, where there are 34, a statement extending over a considerable length of time gives an increase of 23 per cent. in power and a saving in fuel of 15.8 per cent. It may be noted that the air distributor only may be applied to tubular boilers where the arrangement for mixing the gases cannot be employed. A number of other instances might be cited.

We may also mention a new tube for tubular boilers which is intended to increase the action of the heat of the gases, and consequently the surface of absorption. This is the ribbed tube, invented by M. Servé, of Givors, and which is shown in figs. 1 and 2, which give sections of tubes of this kind respectively of 50 mm. and 80 mm. in diameter.

We have heretofore, said that the radiating power of gases being almost nothing, it follows that their heat can be transmitted only by contact, and that the solution of the problem consists in the increase of the surface of contact; it is for that reason that M. Servé has devised this new tube. The gases which enter the tubes travel in parallel layers through the tube and the portions in contact with the surface are quickly cooled; but as they always form the external part of the gaseous column, they form a very poor conductor for the heat contained in that part in the central portion of the tube, so that the total mass reaches the chimney without having given up a proper quantity of its heat. M. Servé has substituted for the ordinary smooth tube a tube carrying inside longitudinal ribs which penetrate almost to the center and carry away the heat from the gases, saving a considerable

amount, which would otherwise be lost, while the metal, being a quick and easy conductor, carries to the outside the heat of the different layers of gases.

The use of these tubes, as shown by experiment, has increased the vaporizing power of boilers to an unexpected degree. From a number of comparative trials made at the Arsenal of Brest with ordinary tubes and with ribbed

Fig. 1.

Fig. 2.

tubes in the same boiler, it was found that the average economy realized with natural draft was 15 per cent. and with forced draft 20 per cent., which is a very notable saving. It was found, moreover, that the ribbed tubes did not in the least impede the draft or injure the firing qualities of the boiler.*

HEATING FEED-WATER.

There are two systems of heating feed-water for boilers.

1. By the exhaust steam.

2. By utilizing the flame or heat of combustion after its passage through the fire-box.

The majority of the steam-engines in use are non-condensing, and the exhaust steam is allowed to escape into the air. If this exhaust steam is used to heat the feed-water a considerable saving may be realized.

If we take a boiler producing steam at an effective pressure of 6 kg. (about 85 lbs.), each kilogram of steam requires

$$606.5 + 0.305\, t - t' = 655 - 15 = 640 \textit{ calorics}$$

for its vaporization, if water is taken from the reservoir or tank at a temperature of 15° Cent. (59° Fahr.).

If, on the other hand, the temperature of the water is raised to 90° Cent. (194° Fahr.) by a good heater, the consumption of heat will not be more than

$$655 - 90 = 565 \textit{ calorics},$$

and the saving will be

$$\frac{(640 - 565) \times 100}{640} = 11.7 \text{ per cent.}$$

If the machine used is a condensing engine, and the water is taken at 30° Cent., the amount of heat required will be:

$$655 - 30 = 625 \textit{ calorics}.$$

If the water is raised by the heater to 90° Cent., the amount of heat will not be more than

$$655 - 90 = 565 \textit{ calorics},$$

and the saving effected will be:

$$\frac{(625 - 565) \times 100}{625} = 9.6 \text{ per cent.}$$

This shows incontestably that heating the feed-water by the exhaust steam is advantageous from an economic point of view. There are many heaters in use which are, as a rule, simple, not very costly, and requiring very little care or expense for their maintenance.

Whenever the exhaust steam of the engine is not utilized in this way, we ought, if the arrangement of the plant permits, to place near the boilers feed-water heaters having a large heating surface and tubes of a small diameter* in such a way as to utilize a part of the heat carried by the hot gases, and to prevent them from reaching the chimney at a temperature over 200° Cent., which is more than enough to obtain a good draft when the passages and the smoke-stack are properly proportioned.†

By the use of these heaters we may realize an economy which will be not less than 8 per cent., and which may increase to 12 per cent. when the water reaches the boiler at a temperature from 80° to 100° Cent.

The heater also has an advantage in preserving the boilers, since by its use we avoid the violent expansion and contraction which is produced when the feed-water is cold. There is also the further advantage that by heating the water, we cause the precipitation of the soluble calcareous deposits which are found in the feed-water, where they are dissolved by the presence of an excess of carbonic acid. Under the action of a temperature below 100° Cent. such water will deposit the greater part of the carbonate of lime which they contain, so that the deposit in the boiler will be very light.

It should be well understood that a feed-water heater has no action upon waters containing insoluble salts, such as the sulphate and chloride of lime, which are precipitated only at the moment of ebullition, and which form deposits attaching themselves firmly to the most heated surfaces. The difficulty of removing these deposits formed by impure water is a serious inconvenience in tubulous boilers, even in those forms where the fire-box can be removed. These boilers require very pure water, unless we are prepared to undertake frequent cleanings, which are sometimes very difficult to effect. For such boilers we must purify the water before feeding it, the result being that where the water is not of very good quality, many manufacturers prefer boilers with interior fire-boxes, of a form more easy to clean. The repairs are then less frequently required and less expensive.

For heaters of this class the water passing through should be forced in the opposite direction to the gases—that is to say, the cold water should reach first the surfaces last exposed to the action of the hot air and gases. It is best also to keep these heaters as clean as possible, and not to permit them to be covered with soot or ashes, in which case the results would be decreased to a serious extent.

* Similar trials have been made recently in this country with very nearly the same results. It may be mentioned that the Servé ribbed tubes are now being tested in actual service in a number of marine boilers, and are shortly to be tried in several locomotive boilers.

* The conducting power of liquids being low, to favor the transmission of heat it is best to make the heating surface of a heater as large as possible, and to make the tubes as small as the nature of the water will permit, in order to diminish the thickness of the layer of water to be heated.

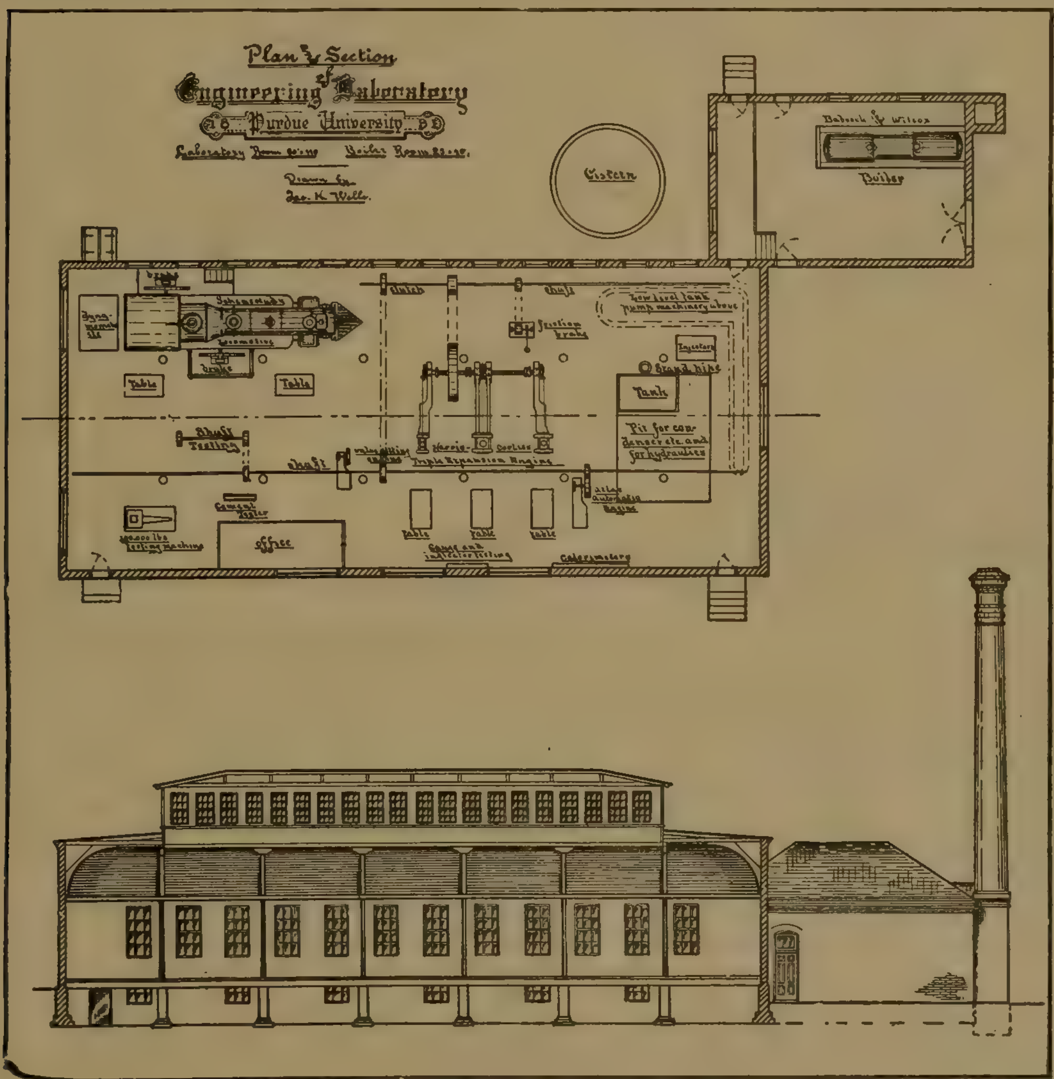
† To determine the temperature of the gases passing to the smoke-stack, we generally use a mercurial which is placed directly in the current of smoke, and so arranged that it can be read without removing it. If the temperature of the gases exceeds 330° Cent., a pyrometer must be used.

The influence of the amount of air furnished is much less in boilers furnished with heaters having large surfaces, than in those which have not this addition. A very slight difference—about 3 per cent.—exists in favor of a strong draft for apparatus of this class, while in others there may easily be a loss of 12 per cent. where the draft is too strong and too great a quantity of air is furnished.

(TO BE CONTINUED.)

## AN EXPERIMENTAL LOCOMOTIVE.

THERE is now being placed in the Engineering Laboratory of Purdue University, at La Fayette, Ind., a 17 × 24-in. Schenectady locomotive, which is to be so mounted that its performance may be carefully tested while being run under conditions quite similar to those of the track.




The engine is one of its maker's standard forms, having drivers 63 in. in diameter, and weighing 85,000 lbs. It is completely equipped with the Westinghouse driver-brake system, and has a headlight from the A. E. Williams Company, of Utica, N. Y. The driving-wheels of the locomotive, instead of resting upon a rail, will be supported by large wheels mounted on shafts which are carried by fixed bearings. These bearings are bolted to a heavy foundation. The locomotive is held in its position on top of the supporting wheels by its draw-bar, which on the road would be used to connect it with the train, but which in the present case is to be connected to a peculiar form of dynamometer or scale. This dynamometer is to weigh the pulling tendency exerted by the engine in a horizontal direction. When the driving-wheels revolve, the engine, instead of moving ahead, remains stationary and the supporting wheels turn backward. In other words, instead of the engine moving ahead on the track, the track—that is, the periphery of the supporting wheels, moves behind. It will be seen that, if the supporting wheels turn without friction, there will be no tendency on the part of the engine to move horizontally in one direction more than another. If, however, a resistance is offered to the turning of the supporting wheels, the engine will tend to move horizontally with a force equal to this resistance. The plan of mounting includes four powerful Alden friction brakes fixed to the shafts carrying the supporting wheels. By means of these brakes the engine may be loaded with a pulling resistance which may be varied from almost nothing up to the full pulling capacity of the engine. By this means, therefore, the engine may be run continuously under conditions similar to those on the track, and it is expected that while thus run, many of the problems relating to the efficiency of the locomotive can be much more carefully studied than when actually running along the road. A Sturtevant steam blower is located above the engine, but not connected with it in any way, for the purpose of taking up and carrying away whatever may be discharged from the locomotive stack. This insures perfect ventilation and freedom from dust in the laboratory.

It may be added that the locomotive described in the foregoing forms but a single feature of the new Engineering Laboratory at Purdue. There is besides a Harris Corliss triple-expansion condensing engine having cylinders 8, 15 and 22 in. in diameter by 24 in. stroke; a 100-H.P. Babcock & Wilcox boiler; a 12-H.P. Otto gas engine; all provided with accessory apparatus necessary for careful work in testing. There is also an experimental stand-pipe, in which may be maintained any desired head for hydraulic experiments, and in connection therewith are high-level and low-level tanks with weir-plates between. There are two Morris centrifugal pumps; a No. 5 Dean steam-pump; several injectors; a 13-in. Leffel water-wheel. There is also a 100,000-lbs. Olsen testing machine; a 2,000-lbs. Olsen cement tester; a 10-H.P. transmitting dynamometer; a 50-H.P. Alden friction brake, and a large amount of small miscellaneous apparatus.

## THE FORGING PRESS.

(Paper read by W. D. Allen before the British Iron and Steel Institute.)

In the production of heavy forgings from cast ingots of mild steel, it is essential that the mass of metal should be operated on as equally as possible throughout its entire thickness. When employing a steam hammer for this purpose it has been found that the external surface of the ingot absorbs a large proportion of the sudden impact of the blow, and that a comparatively small effect only is produced on the central portions of the ingot, owing to the resistance offered by the *vis inertiæ* of the mass to the rapid motion of the falling hammer, a disadvantage that is entirely overcome by the slow though powerful compression of the hydraulic forging press, which appears destined to supersede the steam hammer for the production of massive steel forgings.

The press now brought under notice was designed to be more or less automatic or self-acting, and to insure the perfect parallelism both of flat or square masses and of round shafts without being dependent for their truth on the skill of the operator.

The forging press about to be described has been erected and in operation some time. It works most satisfactorily, and, on the whole, is found to be a most efficient and useful tool.

In this press the force-pump and the large or main cylinder of the press are in direct and constant communication. There are no intermediate valves of any kind, nor has the pump any clack-valves, but it simply forces its cylinder full of water direct into the cylinder of the press, and receives the same water, as it were, back again on the return stroke. Thus, when both cylinders and the pipe connecting them are both full, the large ram of the press rises and falls simultaneously with each stroke of the pump, keeping up a continuous oscillating motion; the ram, of course, traveling the shorter distance, owing to the larger capacity of the press cylinder.

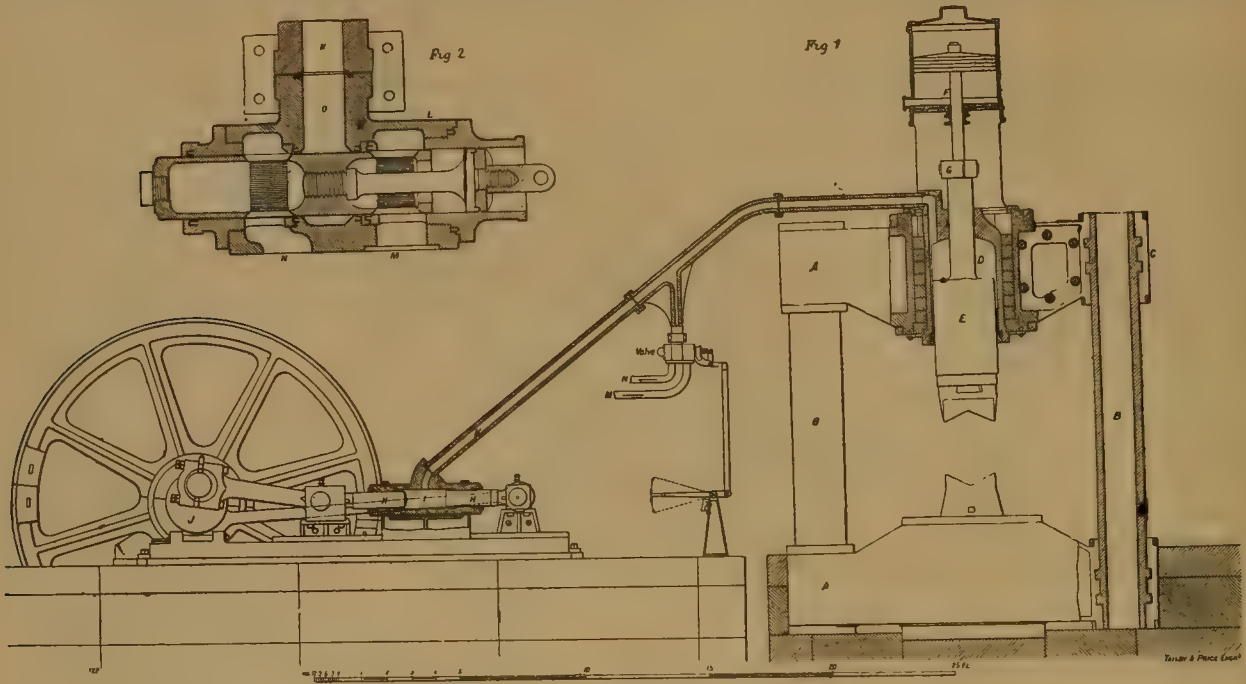
The diagram herewith shows the press and pumps. The top and bottom portions of the framing *A A* are alike, and from the same pattern, each consisting of two castings, held by bolts and steel hoops, as shown.

The main columns *B B* are hollow; they have annular projections or rings *C C* cast at each end, which fit into corresponding recesses, cast in the top and bottom frame pieces.

The large press cylinder *D* is fitted and held in the top frame; the anvil block rests in the bottom frame. Weldless steel hoops are shrunk on to the cylinder to give additional strength, as clearly shown in section. *E* is the main ram. It has a strong shank to it, which passes through the top of the cylinder, acting as a guide. *F* is a steam cylinder with piston, the piston-rod of which passes through the gland at the bottom of the cylinder and is attached to the shank of the ram. *G* is a cross-head working in guides, thus preventing the ram from turning round.

The force-pumps may be appropriately termed "duplex," the ends of faces of the two plungers *H H* advancing and receding to and from each other simultaneously at each stroke. They work into opposite ends of the pump cylinder *I*. This cylinder has no bottom, and becomes simply a strong tube. The two plungers are worked by a three-throw crank *J*, the two side throws of which are on exactly opposite centers to the middle throw. The two side throws give motion to the plunger furthest from the crank, and the strain is a thrust or push. By this arrangement it will be observed that an absolute balance of force is obtained, and all strains between the crank and pump are avoided.

As before observed, a free communication is at all times maintained between the pump cylinder and the press cylinder. This is done through the pipe *K*, and when all are full of water, and the engine working, an ascending and descending motion is imparted to the press ram at each revolution of the crank, the descending motion being given by the press plungers *H H*, advancing toward each other and forcing the contents of the pump cylinder into the press cylinder, the ascending motion taking place by means of the steam piston, which, on the return stroke, raises the ram, and forces the water back on to the pump plungers as they recede from each other; so that as long as there is no waste of water by leakage, and its quantity is not increased or decreased, the press ram will continue to oscillate at the same distance from the anvil, and could only operate on work of that exact size. The ram has, therefore, to be raised or lowered to suit the various requirements of work in hand, and to effect this a source of supply of water under a pressure of about 250 lbs. has to be provided, which, when admitted into the press cylinder, has sufficient force to overcome the power of the steam in the steam cylinder, sending the steam back into the boilers. By this means the ram is rapidly brought down any required distance; on the other hand, the power of




HYDRAULIC FORGING PRESS.

steam immediately raises the ram upon the water being allowed to escape.

The valve used for the rapid admission and escape of water becomes, therefore, rather an important feature and is shown in fig. 2. It consists of a cylindrical casing, having a hollow cylindrical valve or plunger, working endwise through hydraulic leathers ; at each end of this valve or plunger very fine slits are sawn lengthwise through its sides or walls. The principle of the valve is the allowing of the admission and escape of water through the fine slits, by moving the valve endwise until the fine slits pass the hydraulic leather ; the set of slits at one end of the valve being for the admission of water, and those at the other for the escape.

*L* is the casing bored through and fitted with hydraulic leathers shown in section. *M* is the inlet, *N* the outlet, and *O* a passage into the pipe *K*. The valve or plunger is fitted pretty freely into the casing, and is capable of being removed endwise. It is hollow, with a solid division in the center, the hollow forming a sort of cup on each side of the solid part, and through the side walls of these cups the fine slits are cut.

When it is desired to bring the press ram down, the valve is moved endwise to the left until the fine slits pass the hydraulic leather, and a passage is thereby opened from the inlet *M* through the slits, and water is admitted into the passage *O*, and then on to the pipe *K*, and the ram at once descends. When it is desired to raise the ram the valve is moved to the right, and water passes out through the other set of slots, and away by the outlet *N*, and the ram at once ascends by the action of the steam.

It should be observed that at the time the slits pass the leather the low pressure only is in operation, and at the moment of impact of the ram upon the work the valve is always in its neutral position, the position shown in the diagram, the plain body of the central portion of the valve, with a cup leather on each side, being all that is exposed to the great pressure.

The proper time for the additional water is when the pump plungers are receding from each other, and the valve should always be put in its neutral position before the ram face comes upon the work. This arrangement of valve is found to operate most successfully, and the change of position of the ram is effected as quickly as is necessary or desirable. The valve, being in perfect equilibrium, is most easily worked by a handle, brought to a convenient position for the operator to see the work in hand.

The ram may be raised or lowered for its entire range in very few seconds. It can be brought down to the greatest nicety a little lower down each stroke, enabling forgings to be made correct to dimensions, or in case of any sudden occurrence, when it is found undesirable for the impending pressure to take place, the stroke can instantly be averted by moving the valve to the right, although the face may even be in contact with the work. The ram, in fact, is perfectly under control, and almost as lively as the tup of a hammer. An accumulated power is obtained by two heavy fly-wheels on the crank-shaft of the pumps, the momentum of which imparts very great force at the moment of impact of the ram, at which time the cranks approach and turn their centers.

As a security against accident, and a precaution against this force becoming too great, a system of safety-valves has been devised (although not shown in the diagrams). It consists simply of a steam cylinder and piston, the piston-rod of which works into a small hydraulic cylinder that is in constant connection with pipe *K*. Steam is admitted into the steam cylinder at the opposite end to that of the piston-rod, and when the hydraulic pressure on the end of the piston-rod becomes sufficient, it forces the steam back into the boilers. Thus, if the steam piston is 60 in. in diameter, and the piston-rod 6 in. in diameter, and the pressure of steam 50 lbs. per circular inch, a hydraulic pressure on the end of the piston-rod of 5,000 lbs. per circular inch will be an equivalent, and a pressure exceeding that will force the steam back into the boilers, and relief for the water will thereby be obtained.

The press ram makes a stroke of $2\frac{3}{4}$ in., and its diameter is 30 in., so that at a pressure of 3 tons per square inch (deducting the area of the shank) we have a power of 1,700 tons. But, of course, no pressure is developed until resistance takes place ; hence no power is lost or consumed (except what is lost by friction) until the ram face comes into actual contact with the work, and then sufficient pressure only is developed and consumed to do the work. The press was fitted by W. & J. Galloway & Sons, of Manchester, and with the exception of the steam cylinder *F*, is constructed entirely of steel. The form and strength of all the parts have proved to be capable of sustaining the sudden and great strains to which they are subjected, and no springing or flinching takes place—the ram always descending to the same spot, whether it has to press 2 in. into an ingot, or has nothing to do. This has been found useful in rounding-up, for when the ram is once brought down to the right point to give the required diameter, the work has only to be regularly turned round. Of course all has to be dead tight, but there are no joints except cupped leather ones, and very few of those.

## CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

### CHEMISTRY APPLIED TO RAILROADS.
### XXIII.—SOAP (*Continued*).

By C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad.



(*Continued from page* 494.)

Our specifications for soap have been revised twice or three times, and need another revision in one or two particulars, which we will mention a little later. The specifications at present in force are as follows :

PENNSYLVANIA RAILROAD COMPANY.

*Motive Power Department.*

SPECIFICATIONS FOR SOAP.

All soap will be bought by the pound. A shipment of toilet soap or common soap having been received, one cake or bar taken at random will be subjected to examination, and the shipment will be accepted or rejected on this sample cake or bar. The amount of soap to be paid for in a shipment of toilet and common soap will be determined by the amount of combined alkali or its equivalent in the shipment, and this will be determined by multiplying the amount of combined alkali in the sample cake or bar by the number of cakes or bars in the shipment, and dividing this product by the amount of combined alkali in a pound of soap as detailed below. The amount of detergent for cleaning paint and varnish in a shipment will be determined by the net weight of the material as received.

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* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona.

The articles will contain information which cannot be found elsewhere. No. I, in the Journal for December, 1889, is on the Work of the Chemist on a Railroad ; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied ; No. III, in the February number, and No. IV, in the March number, are on Lard Oil ; No. V, in the April number, and No. VI, in the May number, on Petroleum Products ; No. VII, in the June number, on Lubricants and Burning Oils ; No. VIII, in the July number, on the Method of Purchasing Oils ; No. IX, also in the July number, on Hot Box and Lubricating Greases ; No. X, in the August number, on Battery Materials ; No. XI, in the September number, on Paints ; No. XII, in the October number, on the Working Qualities of Paint ; No. XIII, in the December, 1890, number, on the Drying of Paint ; No. XIV, in the February number, on the Covering Power of Pigments ; No. XV, in the April number, on How to Design a Paint ; No. XVI, in the May number, on Paint Specifications ; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint ; No. XIX, in the July and August numbers, on How to Design a Paint ; No. XX, in the September number, on Disinfectants ; No. XXI, in the October number, on Mineral Wool, and No. XXII, in the same number, on Wood Preservative ; No. XXIII, in the November number—continued above—on Soap.

These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these Contributions to Practical Railroad Information of special value in indicating the true character of the materials they must use and buy.

*Toilet Soap.*

The material desired under this specification is a neutral soda soap, as free as possible from water, mineral matter, carbonated alkali and uncombined caustic alkali. It may contain glycerine and sugar, or may be free from them, and may be either transparent or opaque. The cakes should weigh about 4 ounces each. The shape of cake preferred is oval, about 3⅜ inches by 2⅜ inches, with edges about ½ inch thick, and the thickness of cake in the center about 1⅛ inches. The color preferred is somewhat lighter than that of Brown Windsor. The perfume should have the characteristic odor of Lavender, and should not add over five (5) cents per pound to the cost of the soap. It is desired to have the cakes stamped on one side with the initials of the Road to which the soap is furnished, and each wrapped in soft paper. The manufacturer may put his stamp on the opposite side of the cake.

In determining the amount of soap in a shipment, 630 grains of combined alkali, reckoned as soda [$Na_2O$], will be regarded as a pound of soap. Also in the glycerine or transparent soaps the glycerine and sugar will be paid for, each five (5) grains of glycerine and each twenty (20) grains of sugar being received in place of and regarded as the equivalent of one (1) grain of combined alkali. Transparent soaps which contain less than 500 grains of combined alkali, reckoned as soda [$Na_2O$], or more than 1,000 grains of glycerine or more than 700 grains of sugar per pound, are not desired.

Toilet soap will not be accepted which shows on analysis more than one-fourth of one per cent. of mineral matter or more than one-fourth of one per cent. of carbonated alkali, reckoned as carbonate of soda [$Na_2Co_3$], or more than one-half of one per cent. of uncombined caustic alkali, reckoned as caustic soda [NaOH], or more than one per cent. of common salt; nor if a cylinder of the soap ⅞ inch in diameter, and one inch high, cut from the center of the cake, fails to sustain a weight of 15 pounds for five minutes without crushing or compressing more than $\frac{1}{16}$ inch. Also Toilet Soaps made so largely of cocoanut oil, palm oil, palm-nut oil, or other fat of characteristic smell that they leave their peculiar odor on the hands, will not be accepted.

*Common Soap.*

The material desired under this specification is a neutral soda soap as free as possible from mineral matter, carbonated alkali, common salt, and uncombined caustic alkali. It should be carefully cut in bars weighing about a pound each.

In determining the amount of soap in a shipment, 525 grains of combined alkali, reckoned as soda [$Na_2O$], will be regarded as a pound of soap. No allowance is made for glycerine or sugar in this grade of soap.

Common soap will not be accepted which shows on analysis more than one-fourth of one per cent. of mineral matter, more than one-fourth of one per cent. of carbonated alkali, reckoned as carbonate of soda [$Na_2Co_3$], more than one-half of one per cent. of uncombined caustic alkali, reckoned as caustic soda [NaOH], or more than one per cent. of common salt, nor if a cylinder ⅞ in. in diameter and one inch long cut from the center of the bar when received fails to sustain a weight of five (5) lbs. for five (5) minutes without crushing or compressing more than $\frac{1}{16}$ in.

*Detergent for Cleaning Paint and Varnish.*

The material desired under this specification is a mixture of powdered soap and tripoli or pulverized pumice-stone. The proportions of the two ingredients desired are 70 per cent. tripoli or pulverized pumice-stone, and 30 per cent. soap. The tripoli or pumice-stone should be very fine and free from hard particles. The soap should be as free as possible from water, carbonated alkali, uncombined caustic alkali and common salt, and should be finely ground.

This material will not be accepted if the proportion of tripoli or pumice is less than 65 per cent. or more than 75 per cent., nor if it shows on analysis more than 0.10 per cent. of carbonated alkali reckoned as carbonate of soda [$Na_2Co_3$], more than 0.20 per cent. of uncombined caustic alkali reckoned as caustic soda [NaOH], more than 0.30 per cent. of common salt, more than 5 per cent. of water, or if it contains any other substances than soap and tripoli or pumice, nor if the tripoli or pumice is so coarse or contains such hard particles that it scratches the varnish.

THEODORE N. ELY,
*General Superintendent Motive Power.*

*Office of General Superintendent Motive Power, Altoona, Pa., January* 3, 1888.

With regard to the above specifications, it will be noted we do not buy soap by the cake, but rather by the pound, and that although the manufacturers possibly many times claim to make each cake weigh a pound, we do not accept this as final. It will also be noted that we really have placed our valuation of the soap on the amount of combined alkali that it contains. This is in accordance with the explanation given in the early part of this article, that it is really the alkali combined with the fat that we want for detergent, not the free alkali or the carbonated alkali, but the alkali combined with the fat. One difficulty has arisen in regard to this method of buying soap—namely, the bill cannot be paid until the chemical analysis is made. A number of other plans were tried, but nothing has been found that was as successful as this, and all the annoyance that now results is that parties may have to wait three or four days longer for their money. This has not thus far in practice proved a serious difficulty. One point further. It will be noted that the analysis on which the shipment is paid for, and, indeed, the whole transaction, is based on a single cake of soap selected at random from the shipment. If this single cake happens to be larger than the average of the shipment, the manufacturer gets pay for a little more soap than the shipment really contains. If the single cake happens to be a little smaller than the average of the shipment, the manufacturer does not get pay for quite as much soap as the shipment contains. It is believed that these things will equalize themselves in the long run, and as the requirements of our specifications are moderately strict, we have only found a few parties who were willing to take the pains necessary to make as good a soap as we desire, and consequently their orders have been moderately continuous.

One peculiar concomitant of this method of buying and paying for soap has resulted. Of course the manufacturers are desirous of selling as much soap as possible. If, now, they receive an order for 100 lbs. of soap, and send 100 bars, each of which contains combined alkali—a little less than enough to make a pound of soap—they will not sell as much soap as the order calls for. On the other hand, if each bar contains a little more combined alkali than the equivalent of a pound of soap, the manufacturer is paid for a little more soap than the order calls for. In general, a bar that weighs exactly one pound as the manufacturer ships it, will rarely contain quite as much combined alkali as is the equivalent of a pound of soap according to specifications, owing to the fact that much of the soap is sold soon after it is made, and contains rather more water than a well-seasoned soap should contain. We accordingly find that almost all the manufacturers who supply us with soap are cutting all the bars a little heavy, both, as said above, to counterbalance the water, which is a varying constituent, and also because they know they get paid for all the soap there is in the shipment, even though it may exceed the amount ordered. A parallel to this is found in the oil trade. Originally a barrel of oil contained 42 gallons, but as oil is usually bought by the barrel, the size of the barrel has gradually crept up until now very few barrels contain less than 50 gallons. So with the soaps. We have seen many bars of soap, which nominally weighed a pound, which did not weigh over 11, 12, or 13 ounces. The bars in our shipments now almost universally weigh over a pound. A little reflection will convince every one that the only fair way to buy soap is by the actual value given, and that the method which we have adopted is not only fair to the consumer, but also to the manufacturer.

The peculiarities of the specifications for toilet soap are, perhaps, sufficiently evident without much comment. The glycerine and sugar mentioned, as will be observed, are measured in value in terms of combined alkali. The ratios used were based on the relative commercial prices of the articles involved. It is in the matter of sugar and glycerine that our soap specifications need revision, and we will explain this a little later, when we come to describe the chemical methods of determining the different constituents. We have had little difficulty in getting soaps that were within the limits for mineral matter, for caustic alkali, and for free carbonated alkali, and common salt given in the specifications. Many times manufacturers who do not know accurately what they are doing find that their soaps do not fill our requirements, but it is

believed, after some six or eight years' experience, that the requirements are not excessively difficult. It will be observed that no limitation is placed on the manufacturers as to the kind of fat acid they shall use, except in the toilet soap, that those which leave a characteristic disagreeable odor on the hands shall be avoided. Otherwise than this the manufacturers can use any materials so long as they fill the requirements.

Upon this point it may be well to say that the physical test for hardness was devised as a simple means of controlling the kind of acids used. If the soap is made of all rosin, and shipped before it is dried out at all, it would not stand the physical test, and the same is true of a number of the other fats. In order to meet this difficulty, and at the same time not go into the question of specifying what kind of fats should be used, we devised the physical test, and it has served our purpose charmingly.

It will be observed that in the common soap the amount of combined alkali that is equivalent to a pound of soap is considerably less than toilet soap. This is due to the fact that in toilet soap there is much less water than in common soap. The ordinary common soap contains not far from one-third of its weight water, especially if the soap is fresh. Toilet soap generally does not contain more than 5.00 to 8.00 per cent. water. Due to this presence of water rendering the soap softer, the physical test is much less severe for toilet soap than for common soap. In the detergent for cleaning paint and varnish, the quality of the soap, so far as amount of free caustic and carbonated alkali are concerned, is the same as in the common soap, our idea being to limit the damage to the varnish, due to this constituent, as much as possible. We have had very little difficulty in getting this article in the market, although there is chance for some improvement in the manufacture. The material should be in the form of a powder, and as most of the shipments which we receive are a little lumpy, which we regard as objectionable, it is entirely possible that in the next issue of the specifications a proviso will be introduced to overcome this difficulty.

A circular giving directions for the use of detergent for *Cleaning Paint and Varnish* has been issued. The directions in this circular will undoubtedly be understood by what has preceded. The oil treatment recommended, following the use of the detergent, has been found to be quite valuable, so much so that a car properly cleaned with detergent, and gone over carefully with linseed-oil, looks almost as good as new, provided the varnish has not become cracked. The gloss is largely restored, and the inequalities of the surface are largely filled by this layer of oil. Of course if the varnished surface has become cracked nothing will restore this that we know of except revarnishing. The following in the circular:

PENNSYLVANIA RAILROAD COMPANY.

*Motive Power Department.*

DIRECTIONS FOR USING DETERGENT FOR CLEANING PAINT AND VARNISH.

The ordinary common soap used in cleaning paint and varnish has a very destructive action on the varnish, dissolving it rapidly; a car cleaned two or three times with strong soap suds must be revarnished and in some cases repainted. To diminish this destructive action of the alkali in the soap, is the object of the detergent for cleaning paint and varnish. This detergent is a mixture of tripoli or pulverized pumice-stone with powdered soap, and its cleansing power comes from the slight solvent action of the soap and the scouring action of the tripoli or pumice-stone. The varnish or paint is destroyed to a certain extent by the detergent, but the destructive action is very much less than with soap suds. This material should be used in accordance with the following:

*Directions.*

Go over the surface to be cleaned with a wet sponge, piece of waste or cloth, which has been dipped in the dry detergent. Use plenty of the material but not much water, and rub until the dirt is detached from the surfaces. Wash thoroughly with clean water, using sponge, hose, or soft washing brush. Allow the surface to become dry and then give it a light coat of raw linseed-oil, using a piece of waste or a cloth; what is known as rubbing oil may be used also for the purpose; care should be taken to leave only a very thin layer on the surface. The oil replaces much of the paint or varnish which has been removed by the detergent.

The oily waste or rags should be disposed of with great care, as they are quite liable to take fire from spontaneous combustion. They should never be left in the cars, thrown on the ground or floor, or put away with the cleaning utensils; when practicable they should be burned.

THEODORE N. ELY,
*General Superintendent Motive Power.*

*Office of General Superintendent Motive Power, Altoona, Pa., March* 16, 1888.

The chemistry required in our specifications presents some problems of considerable interest, and we have put a good deal of study on this subject, and are inclined to think that at least our method of determining caustic alkali in soaps is not in common use. Indeed, we may go a step farther, and say we do not know of any other method which will give the free caustic alkali in a soap except the one which we use. We determine in soaps the excess of caustic alkali, the carbonated alkali, the combined alkali, the mineral matter, the common salt, make physical test, and weigh the cake. The reasons for the weight of the cake, the physical test, and the method of making the physical test are sufficiently clear from the specifications.

The common salt is determined by decomposing a weighed sample of the soap with dilute sulphuric acid, sometimes with the addition of a little oil to dissolve the separated fat acid, in order to facilitate decomposition. After the decomposition is complete the beaker is chilled, and the fat acids become a cake. They are then removed and washed. If it is desired to be strictly accurate, a second melting of these fat acids with distilled water, so as to secure complete removal of every trace of common salt from the cake, is made use of. The solution containing the common salt is filtered and then neutralized with carbonate of soda, and then titrated with standard nitrate of silver solution, using neutral chromate of potash as the indicator.

The mineral matter and the carbonated alkali are determined in one operation. A weighed amount, five grammes of the soap, is dissolved in alcohol. If we desire to be strictly accurate in our carbonate of soda determination, we use absolute alcohol, since carbonate of soda is slightly soluble even in 95-per cent. alcohol. For common purposes, however, ordinary 95-per cent. alcohol does very well. The soap dissolves readily, especially under the influence of heat. As soon as solution is complete, it is filtered through paper or in a Gooch crucible and washed with alcohol. The carbonate of soda and the mineral matter remain on the filter. When washing is complete, the carbonate of soda is dissolved from the filter by means of water, and is subsequently determined by the well-known methods of alkalimetry, using phenolphtaline for the indicator. The mineral matter remains on the filter, and is determined by ignition of the filter or drying with Gooch crucible, and weighing in the ordinary way.

If silicate of soda is a constituent of the soap, our experience indicates that quite a large portion of this will appear in the caustic alkali determination, which will now be described, and will render the amount of that constituent so high, that the soap would be rejected on account of caustic alkali. It also shows a tendency to break up in the alcohol solution used in determining the carbonate of soda and mineral matter, as above described, so that we are inclined to think we catch this element in one of these two places. If not, it would, of course, appear later in the determination of the combined alkali.

The excess of caustic alkali in soap is determined as follows: A standard solution of stearic acid in alcohol is prepared and its titer accurately determined. The solution that we use contains about seven and a half grammes of stearic acid to the liter of alcohol. The absolute amount is not essential, but the titer, in terms of the standard alkali, must, of course, be known. Five grammes of the soap to be tested are then placed in a small flask, and 100 cubic centimeters of the stearic acid solution added, and the vessel placed on the steam table or sand bath. Solution gradually takes place, the soap dissolving in the alcohol, and the caustic alkali, as fast as it appears,

combining with the stearic acid in the solution. We also find that under the influence of the heat necessary to produce solution, the carbonate of soda in the soap, if there is any, is slowly dissolved, and if the amount is very small it may completely disappear. We are not quite sure whether this decomposition of the carbonate is due to the fact that we commonly use 95-per cent. alcohol in making the stearic acid solution, or whether the boiling stearic acid solution decomposes carbonate of soda. Whatever the explanation, the fact remains. When solution is complete the liquid is filtered through paper in the ordinary way, and any mineral matter, together with the carbonate of soda not decomposed, is left on the filter. The solution containing the soap and stearic acid is then titered with standard alkali, using phenolphtaline as indicator. The difference between the titer of the 100 cubic centimeters of the stearic acid solution which were started with and that obtained at the end of the operation represents the free caustic alkali together with a part of the carbonate of soda. The remaining part of the carbonate of soda on the filter is obtained in exactly the same way as above described—namely, by the well-known methods of alkalimetry, using phenolphtaline as the indicator. The sum of the caustic and carbonate of soda obtained by these two determinations represents the total of these two constituents present in the soap. The previous determination has, however, given us as accurately as possible the carbonate, and the sum above obtained diminished by the amount of carbonate shows the amount of free caustic alkali in the soap. We do not, of course, reduce the results obtained by the use of the standard solutions to percentages and then subtract the carbonate from the sum of the caustic and carbonate. The actual operation is done in cubic centimeters of the standard solutions. The final results are, of course, calculated to percentages. Duplicate results with this method are extremely close, and, as stated above, we do not know of any other method of getting at the amount of free caustic alkali in a soap better than the one which we use. Of course this problem has been studied a good deal. We have used this method now for some three or four years, and this is the first time that it has been published. It is obvious that there may be three conditions of the soap to be examined.

First, there may be an excess of free caustic alkali along with a neutral soap. It is quite probable that the common method—namely, of dissolving the soap in alcohol and titrating with any standard acid, using phenolphtaline as the indicator, would give the amount of free caustic alkali under this condition. Our own method is likewise, we think, equally reliable.

The second case would be when there is free caustic alkali and free fat—that is, the operation of saponification was not quite completed in the boiling. In this case the ordinary method of dissolving in alcohol fails entirely, since during the solution the free alkali combines with the free fat, and therefore does not appear as it should. In this case our own method gives likewise, we think, and accurately the free alkali, since the free alkali combines with the stearic acid rather than with the unsaponified fat.

The third case would be where there is a deficiency of alkali that is not enough to saponify all the fat. If the excess of fat is unsaponified material, our method would show nothing. If, as happens in many cases, the excess of fat is free fat acid, we always get this by our method.

We have studied soaps and have used analytical methods for the sake of protecting the interests committed to our charge, and accordingly we have not put much study on the material from the soapmakers' standpoint. We have never tried to develop a method which under all circumstances would tell whether there was an excess of fat. This is a problem for the soapmakers rather than for ourselves, since the excess of fat causes us no injury.

The method used in determining the combined alkali depends something on what the previous tests have shown. If there is mineral matter, especially carbonate of lime, or other substances which under the influence of heat would either be alkaline or combined with the soda, we take the sample from which we have removed the mineral matter and carbonate of soda as previously described, and evaporate and burn until all the organic matter is gone. In case no mineral matter is present, five grammes of the soap is put in a platinum dish and the organic matter burned. At the last we usually add a little pulverized chlorate of potash, to assist in removing the last traces of carbonaceous matter, and also to oxidize any sulphides which may be present, and which are formed by the deoxidation of a trace of sulphate which may exist as impurity in the soap. It is obvious that in the first case all the alkali that was in the soap originally as combined alkali and caustic alkali is now in the platinum dish. In the second case all the combined, caustic, and carbonated alkali that was in the soap are now in the platinum dish. These are dissolved in water and determined by the well-known methods of alkalimetry. A deduction for the caustic in the first case, and for the caustic and carbonate in the second case shows the combined alkali. The whole operation of making all the determinations requisite for examining a soap need not take over one-half a day, and a good deal of the time, as would naturally be supposed, would be taken up in obtaining the solutions. Of course in a well-regulated laboratory other work is done while the solution is going on.

In addition to the above determinations it will be noted that we state that the sugar and glycerine in these kinds of soap will be paid for, and this, of course, involves a determination of these constituents. It is in regard to these two that our specifications, we think, need revision, since we find by actual experience that we have not yet been able to get a satisfactory method for the determination of the sugar and glycerine. We have experimented a good deal with the Benedikt-Zsigmondy method for the determination of glycerine, by converting the glycerine into oxalic acid, but have not always succeeded in getting satisfactory results with it. As soon as we obtain a satisfactory method for the determination of glycerine, it is probable we will revise our specifications, and require a small percentage of glycerine as an essential constituent of all our toilet soaps. Of course the sugar is previously separated from the glycerine, and is subjected to a separate determination. At present we are not encouraging the purchase of glycerine soaps, for the reason that we do not feel satisfied with our method of determining this constituent.

In the next article we will try to treat the subject of Steel for Springs quite at length.

(TO BE CONTINUED.)

## ROLLING FLUID METAL.

In a paper read recently before the Iron and Steel Institute, Sir Henry Bessemer described his early attempts to roll sheets of steel from molten metal, the partial success which he had attained, and the apparatus which he had then patented. After this historical prelude, he continued as follows:

Having thus freely criticised my first imperfect form of apparatus, I will proceed to explain in what manner I now propose to remedy these defects. These suggested improvements will be readily understood by reference to figs. 1, 2 and 3, annexed; and here I beg to observe that I have not gone into the many details necessary for the construction of rolling mills of this description, but have merely given such an illustration of the general scope of my proposals as will enable them to be understood.

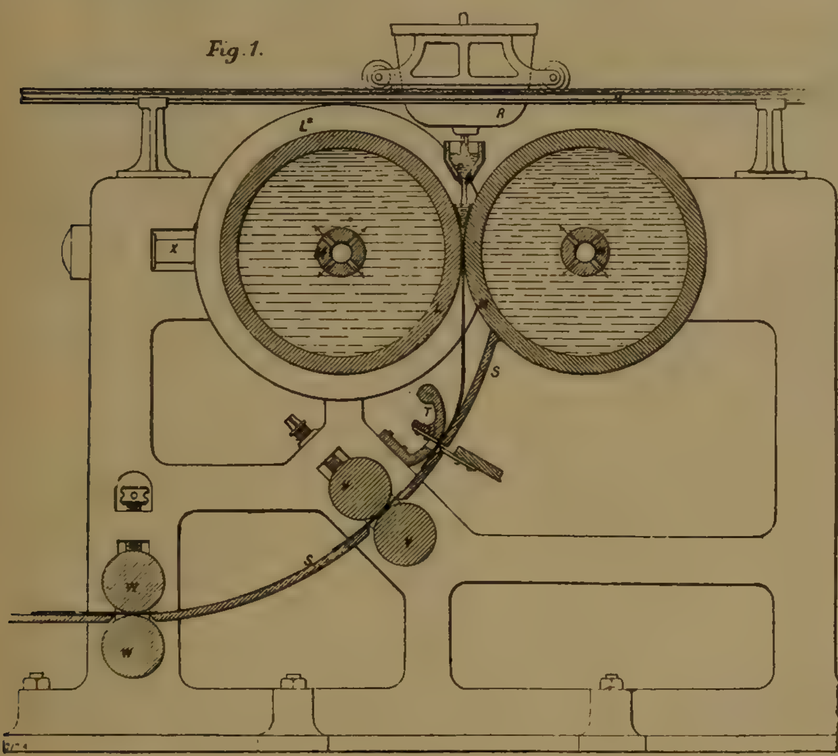
The rolls *L* and *M* consist of two hollow drums through which a tubular steel axis *N N* passes, and conveys a plentiful supply of water for keeping the rolls cool.

The brasses which support the roll *M* are fixed, while those which support the roll *L* are movable in a suitable slide, and are pressed on by a small hydraulic ram *X*, which is in free and uninterrupted communication with an accumulator, so that at any time should the feed of metal be in excess, the roll *L* will move back and prevent any undue strain in the machinery, the only result being a slightly increased thickness at that part of the sheet of metal, a defect which, as it extends parallel across the

whole width of the sheet, will be easily corrected in the next rolling operation.

The rolls, by preference, may be made 3 ft. or 4 ft. in diameter, each having a flange on one end only, and thus form a trough with closed ends for containing the fluid metal.

In order to obtain a regular and quiet supply of metal, I employ a small iron box or reservoir *P*, lined with plumbago or fireclay, along the bottom of this reservoir. Some 10 or 20 small holes of about ¼ in. in diameter are neatly molded by a row of conical brass pegs. The reservoir is provided with a long bar or handle at each end. By means of these bars, the reservoir is supported on the side frames, the bars falling into suitable notches made in the roll frame for that purpose.




ROLLING SHEETS FROM LIQUID METAL.

And here I would observe that the reservoir *P* should be well dried, and its interior surface heated to redness prior to its use. For this purpose a small furnace or stove should be placed near to the rolls, the stove having two or three rectangular openings on its upper side, in size corresponding to the interior of the reservoirs, which are to be inverted over these openings, the hot products of combustion passing freely through the row of holes, and bringing up the interior surface of the reservoir to a full red heat. In this state the reservoir is to be placed in its proper position in the roll frame, immediately after the arrival there of the ladleful of fluid metal.

A pair of rails *Q* are supported on the roll frames and serve for the conveyance of the ladle *R*, which is mounted on wheels and brings the metal direct to the rolls, or to any number of pairs of rolls that may be placed in line.

The ladle is provided with one or more valves or stoppers of the usual kind, by means of which the supply of metal to the reservoir *P* may be easily regulated; the several small streams from the reservoir will deliver an almost constant quantity of metal, varying only slightly as the operator regulates the head of metal in the reservoir—a means of regulating which a little experience would allow him to utilize with great advantage; from the smallness of the head of metal in the reservoir the several streams will fall quietly without splashing. These streams do not fall direct on to the rolls, but into a small pool formed between the thin films solidifying against the cold surface of the rolls, the metal at all times being free from floating slags.

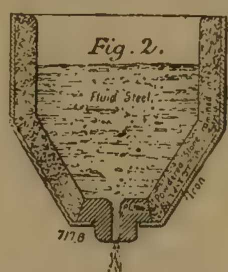
The speed of the rolls also affords a means of regulating the quantity of metal retained between them; and as a pair of 4-ft. rolls would only require to make about four revolutions per minute, a quick-running engine could easily be provided with differential speed-gearing, so as instantly to alter the speed of the rolls to the very small extent ever required during the rolling process.

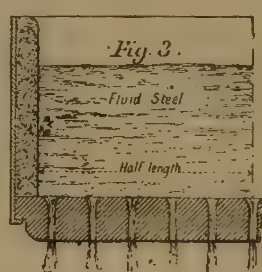
The thin sheet of metal, as it emerges from the underside of the rolls, is received between the curved guide plates *S* and *T*, to the latter of which a cutting blade *U* is bolted. Beneath the guide plate *S* a similar cutting blade is arranged to suddenly move forward by a cam and cut the thin sheet in two, the piece so cut afterward passing between the second pair of rolls *V V*, from which it again descends by gravity, and passes between the third pair of rolls *W W*, and is delivered on to a horizontal table, or it may be allowed to slide down the inclined end of a cistern of water, and moved slowly forward. By these means it will be possible to cool and stack a ton of plates without any labor or trouble.

The thickness of plates capable of being produced will much depend on the size of the rolls; if drums of 10 ft. or 12 ft. in diameter are employed, it is probable that plates of ⅜ in. in thickness could be produced, or even thicker. The central space between drums of such large diameter would represent a sort of plate ingot mold with nearly parallel sides for some 8 in. or 10 in. in depth.

When producing sheets of steel, the initial thickness of which does not exceed $\frac{1}{10}$ in., it might at first sight appear that the finished plate, with only two more rollings, would not get sufficient work done upon it to develop the same degree of toughness and cohesion that would be obtained by the many rollings which the present system necessarily involves; but a little consideration will render apparent the entirely different conditions under which the formation of the plates takes place.

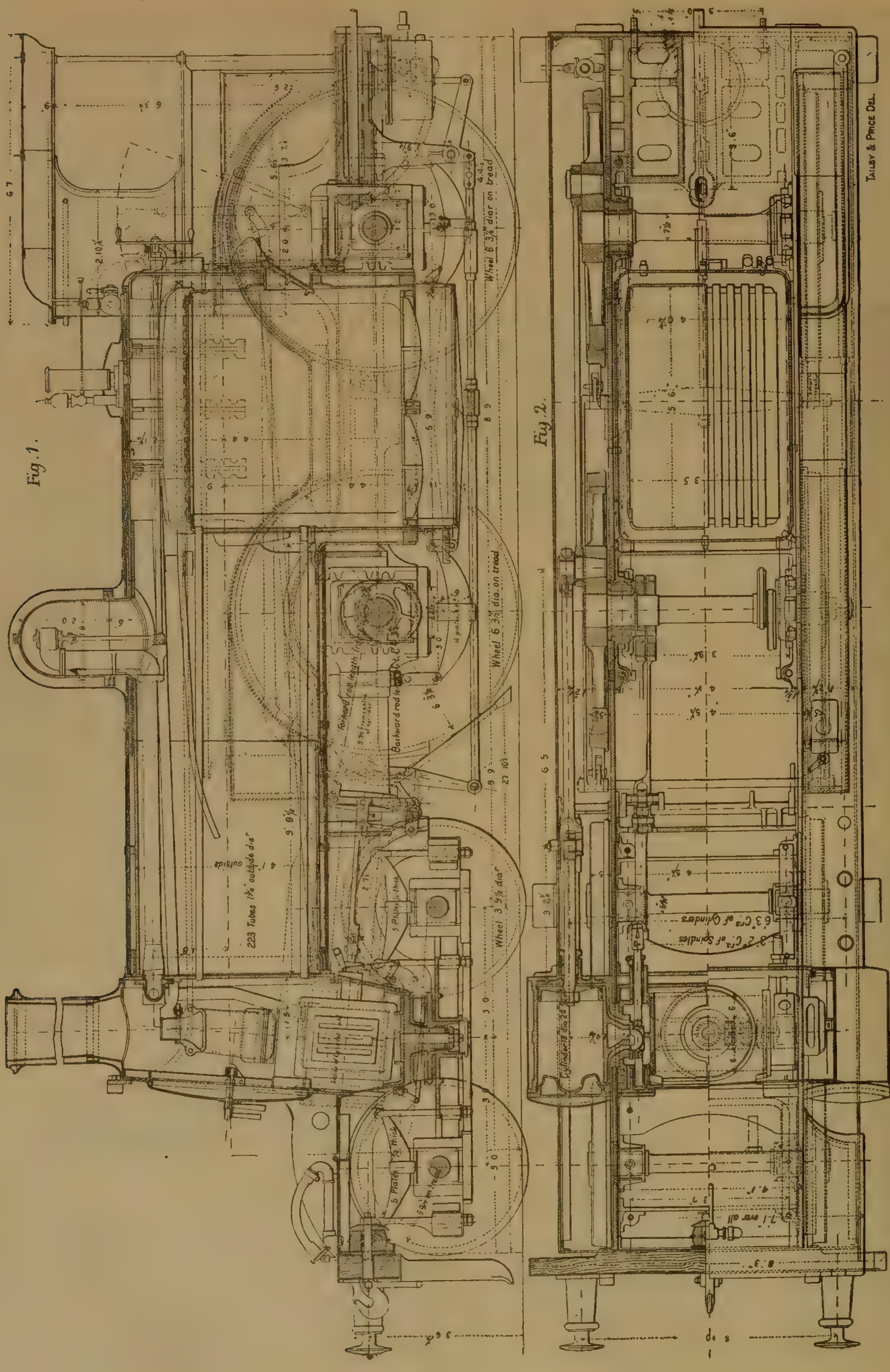
Mild cast steel is a crystalline substance, and follows the inevitable law of all crystalline bodies, in so far as the size of the crystals depends on the bulk of the mass and the time allowed for their formation; the longer the time




allowed, and the greater the mass, the larger are the crystals obtained; their planes of cleavage are also more clearly defined, and are more easily separated from each other, or, in fact, have a less amount of cohesion.

A cast ingot of 1 ft. square, quietly reposing in a soaking pit or heating furnace, may go on crystallizing for two or three hours, and develop a coarse crystalline structure, but, in rolling fluid steel in the manner proposed, we have, in place of a 10-in. ingot, a sheet of one-hundredth of that thickness only, and in lieu of the two or three hours




STANDARD PASSENGER LOCOMOTIVE, HIGHLAND RAILWAY, SCOTLAND.

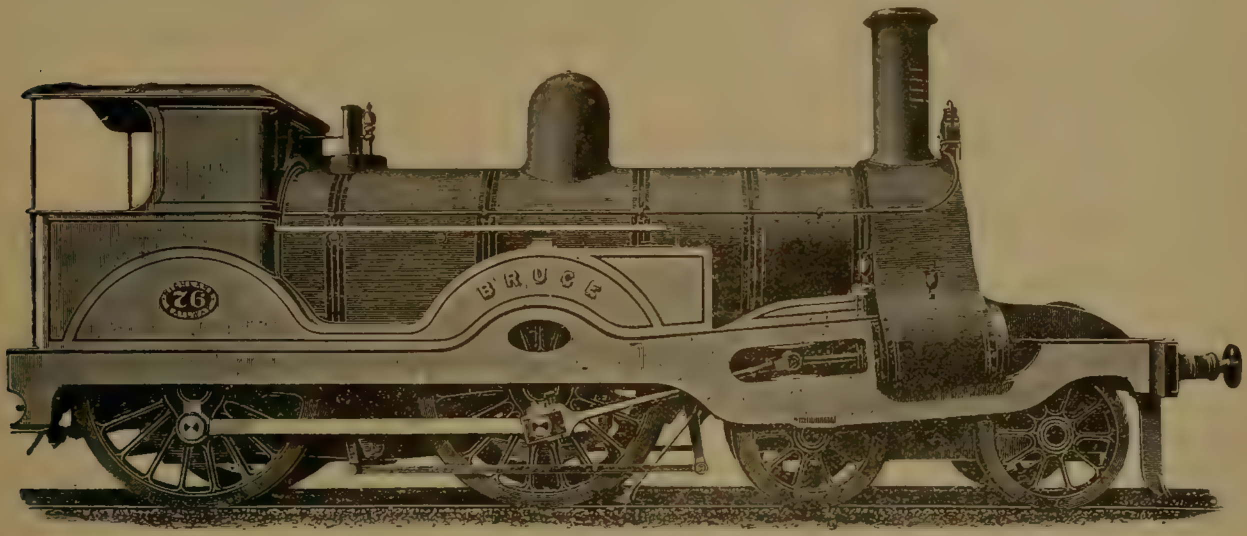
allowed in ordinary cases for the development of crystals, we have, when using a 4-ft. pair of rolls, making four revolutions per minute, a transition from absolute fluidity to absolute solidity in just one-half of a second of time, in a mass of only $\frac{1}{10}$ in. in thickness; and if crystals are developed at any period during the half second of time occupied by this transition, they must be microscopic indeed, and possess but little if any of the properties that are developed in large masses during hours of repose in the soaking pits; hence it appears to me highly probable that the homogeneous fluid metal will pass at once into a perfectly homogeneous uncrystalline body, and being subjected to fluid, semi-fluid and solid pressure in rapid succession, will develop the full cohesive force and toughness of which the metal is susceptible.

It will be at once perceived that in this mode of disposing of a ladleful of steel in the rolls we avoid the cost and wear and tear of casting molds, and the labor of their removal and rearrangement at each casting operation, also the need for soaking pits or reheating turnaces, with their accompanying cost of labor and fuel. There will also be no loss arising from the waste ends of piped ingots, etc.

It will be understood that thin sheets so produced will not acquire any scale during the single minute they are exposed to the oxidizing influence of the atmosphere prior to their immersion in the water-tank, and in consequence of there being no overlapping of plates in rolling there will be but little loss of metal in shearing.

With reference to the speed of production, let us assume the mill to be fitted with a pair of 4-ft. diameter rolls, 18 in. wide, and making four revolutions per minute, and set to produce a sheet having an initial thickness of $\frac{1}{10}$ in., and rolled by the third pair to $\frac{1}{20}$ in., we should thus have a surface velocity of the first pair of rolls equal to 50 ft. per minute; and making when finished 100 plates 18 in. by 12 in., $\frac{1}{20}$ in. thick, and weighing 300 lbs., or equal to a production of one ton of plates in 7½ minutes.

Hence it becomes a question which is the least costly mode of dealing with a ladleful of fluid steel?—forming it into massive ingots in molds, or making it into thin sheets in the manner proposed.



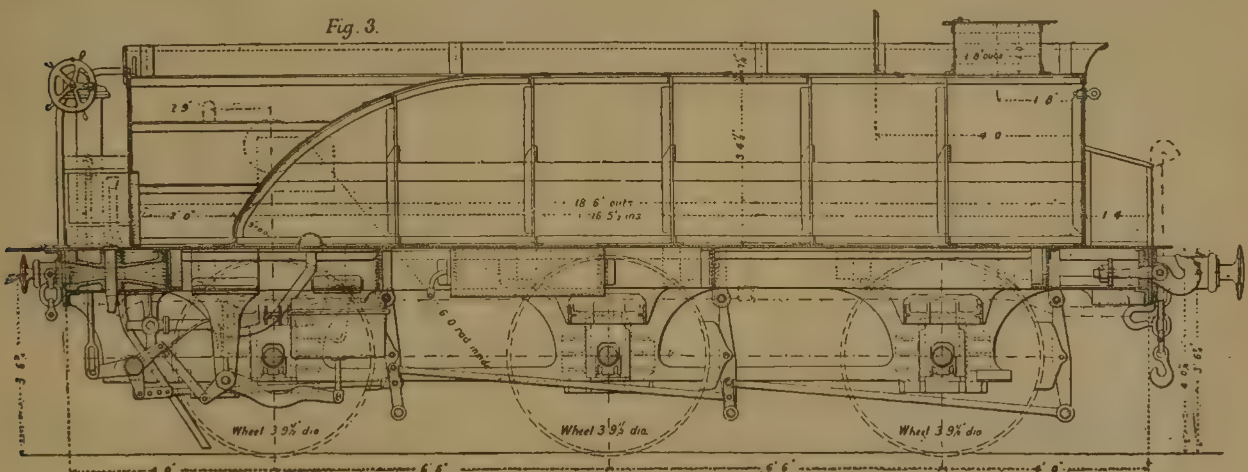
PASSENGER LOCOMOTIVE FOR THE HIGHLAND RAILWAY, SCOTLAND.

## PASSENGER LOCOMOTIVE FOR THE HIGHLAND RAILWAY.

THE accompanying illustrations, from the London *Engineering*, show the standard passenger engine of the Highland Railway in Scotland. This road runs through a rough and hilly country and has many heavy grades, in one place rising 66 ft. to the mile for 17 miles in succession. The traffic is variable, being heavy in summer and very light in winter; but in the winter there is much delay from snow.

The engine is of the eight-wheel type, with four driving-wheels and a four-wheeled truck. The cylinders are outside, with the steam-chests inside, and are placed on an incline of 1 in 12. The cylinders are 18 in. in diameter and 24 in. stroke. The steam ports are 15 × 1½ in. and

*Fig. 3.*



STANDARD TENDER, HIGHLAND RAILWAY.

the exhaust ports 15 × 3 in. The valves have 4 in. extreme travel and 1 in. outside lap. The valve motion is of the Allan straight-link type. Valves, eccentrics and eccentric straps are of cast iron. The slide-bars are of iron, case-hardened, and the slide-blocks are cast iron with a large surface, 72½ sq. in. on each block. The piston-rod and cross-head are in one piece, the cross-head being a plain eye with a case-hardened bush pressed into it, the small end of the connecting-rod being a plain jaw with a case-hardened iron pin through it and the cross-head. The other end of the connecting-rod is solid, the brasses being held up by a single key.

The driving-wheels are 6 ft. 3½ in. in diameter; the centers are 5 ft. 8½ in., of wrought iron, and the tires are of steel, 3½ in. thick. The distance between centers of drivers is 8 ft. 9 in. The driving springs are equalized in the manner usually adopted on eight-wheel engines in this country. The driving-axle journals are 8 in. in diameter and 7½ in. long.

The truck is of the swing-bolster pattern and is carried on four wheels 44½ in. in diameter, the axles being spaced 6 ft. between centers. The wheel centers are of cast steel and are 39½ in. in diameter, the tires being of steel 3 in. thick.

The frames are of the plate type usual in England. The axle-box guides are of steel, with liners of wrought iron, case-hardened. The axle-boxes are of steel.

The engine is fitted with the vacuum brake, which is in use on this road. In addition it has the Chatelier counter-pressure water brake, which is found to work very well and to be of much use on the long heavy grades, both in holding the train and in keeping the cylinders and valves moist when steam is shut off.

The boiler barrel is 50 in. in diameter and 9 ft. 9½ in. long. It is of ½-in. steel and double riveted throughout. The outside fire-box casing is 6 ft. 2½ in. long and 4 ft. 3½ in. wide. The tubes are 1¾ in. in diameter and 10 ft. 4 in. long. The fire-box is of copper and is 66 in. long and 41 in. wide inside. The grate area is 18.8 sq. ft.; the heating surface is: Fire-box, 97.5; tubes, 1,038.5; total, 1,136 sq. ft. The boiler is fed by two Gresham automatic injectors.

The tender tank holds 2,250 gallons of water. The tender has an iron frame and is carried on six 45½-in. wheels, of the same pattern as the engine truck wheels. The tender axles have both outside and inside bearings. The tender wheel base is 13 ft.

In the accompanying cuts fig. 1 is a longitudinal section and fig. 2 a plan of the engine. Fig. 3 is a longitudinal section of the tender and fig. 4 is a perspective view of the engine, showing its general appearance.

The engine weighs altogether 96,320 lbs. in working order, and the tender weighs 71,680 lbs., with tank and coal-box full.

## PROGRESS IN FLYING MACHINES.

By O. Chanute, C.E.

(*Continued from page* 511.)

While the inventors who experimented with flapping wings, with which they tried to raise themselves on the air by muscular effort, doubtless had it in mind eventually to substitute artificial motors, if only they could catch the trick by which the bird flies, there have been a few others who have at the outset designed flapping wings, to be moved by some primary artificial motor. As they generally knew of no such motor, within admissible limits of weight in proportion to its energy, such designs have remained mere projects, and but few experiments have been made.

The proposal of *Gérard*, in 1784, shown in fig. 12, seems to have been among the first. It apparently provides, in addition to the body and wings, for a steering arrangement in front, and for feet with springs to land upon. The inventor omitted to state in his printed description what motive power he intended to use, but an inspection of the drawing suggests the conjecture that the apparatus was to be propelled in part by escaping gases, like a rocket, and in part by flapping the wings through the medium of a gunpowder engine; proposals and experiments with such motors antedating, as is well known, those with the steam-engine. Be this as it may, soon after the success of the locomotive engine on the Liverpool & Manchester Railroad, Mr. *F. D. Artingstall* endeavored to compass an aerial locomotive. He con-

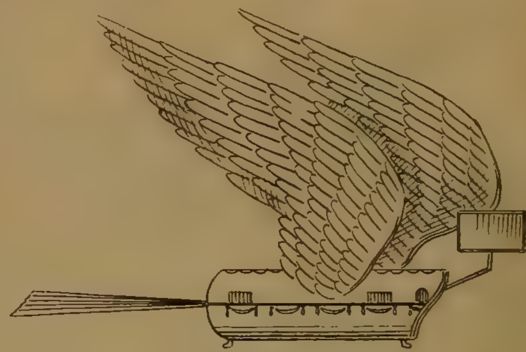


Fig. 12.—GÉRARD—1784.

structed a very light steam-engine, suspended it by a cord from the ceiling, and to the piston-rod he attached wings, which were so constructed that they opened somewhat like a Venetian blind on the up stroke and closed during the down stroke, moving through an arc of 80°. When steam was turned on the wings worked vigorously, but the machine jerked up and down, rushed from side to side, and, in fact, performed all kinds of gymnastic movements except flight. This experiment was terminated by the explosion of the boiler, and a second attempt, in which it was intended to use four wings instead of two, in order to keep up a continuous buoyancy, resulted in a second explosion; after which the experiments were abandoned. In 1868 Mr. *Artingstall*, in a communication to the Aeronautical Society of Great Britain, stated the weak point in his various experiments to have been the lack of suitable equilibrium.

Every experimenter with aerial apparatus has doubtless encountered the difficulty of obtaining in a machine that equilibrium which the bird maintains by instinct, and also of deriving continuous support from the flapping of one pair of wings. These are probably the reasons which led *Struvé* and *Telescheff* to design, in 1864, the apparatus shown in fig. 13, in which five pairs of wings are

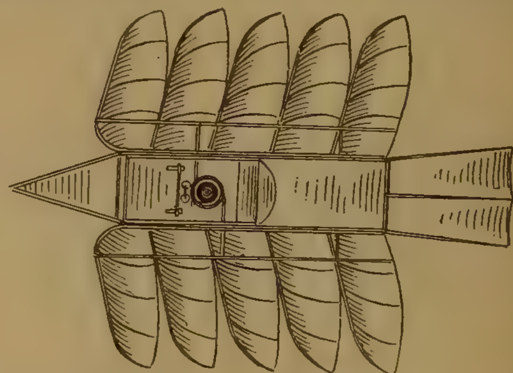


Fig. 13.—STRUVÉ & TELESCHEFF—1864.

attached to a central plane. The only description accessible to the writer states that the wings were moved by human force acting upon a spring, but it is evident that the apparatus was intended to be driven by artificial power, if the designers could only find one sufficiently light for that purpose. That they did not succeed in this seems to be a fair inference from the fact that the machine was not tested by experiment.

At the Exhibition of 1868, of the Aeronautical Society of Great Britain, Mr. *I. Palmer* exhibited a pair of wings

(to be driven by power) attached to a rotating axle, and so arranged that they expanded in the descent and closed in the ascent, like the action of a duck's foot in swimming; this motion being obtained in a remarkably simple manner by a roller running on an eccentric cam, which could be instantaneously changed in position, so as to convert the vertical lifting power into one of horizontal force. It does not seem to have been applied to any flying machine.

At the same exhibition Mr. *I. M. Kaufmann*, engineer of Glasgow, exhibited the working model represented in fig. 14, which was intended as the precursor of an aerial

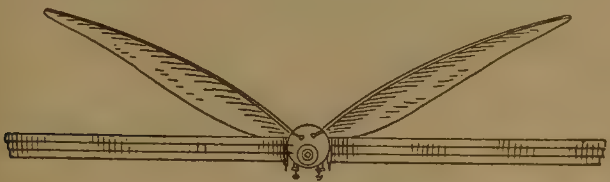


Fig. 14.—KAUFMANN—1867.

steam machine weighing 7,000 or 8,000 lbs. The apparatus consisted of a steam boiler and engine, mounted upon wheels, and propelled by two long wings, which, during the down stroke, were set at an inclined direction backward, and were caused to turn at a forward angle during the up stroke. The main portion of the weight was to be sustained by superposed aeroplanes, and hence the machine should perhaps be described under that head, but it is here included under the head of wings, because of the mode of propulsion. The model weighed 42 lbs., and during the experiments with it its boiler, owing to its small size, was not fired, steam being supplied from an independent boiler. With steam pressure at 150 lbs. to the inch, the wings made a short series of furious flaps, and one of them suddenly gave way about 2 ft. from its base, upon which the other one failed also. The inventor stated that he was then engaged in the construction of a larger machine on the same principle, but since then nothing more has been heard of it. He proposed to secure stability by letting down or raising up a long "pendule" with telescopic joints, so as to adjust the center of gravity and keep the machine in a horizontal position, but it may well be doubted whether this would have proved effective.

At a meeting of the British Aeronautical Society, in 1871, Mr. *R. C. Jay* exhibited a model to illustrate a method which he proposed in order to use wings of any length and weight without loss of power. This consisted of two pairs of oscillating wings moving on the same shaft. It was expected that the forces generated by their motion would hold the machine is equilibrium, and that one pair of wings would be aided by the current of air, or whirlpool, produced by the movement of the other pair. This does not seem to have answered, for in 1877 the same inventor presented a model to the same society, illustrating a method of obtaining a figure of 8 or sculling action with one pair of wings, but at the same time Mr. *Jay* candidly stated that "although he had made a great many experiments, he had not yet succeeded in making a propeller (wings) sufficiently simple and effective for practical purposes."

It is said that about the same time an *optician* of Leipsic made a small steam bird, mounted on a globular steam boiler and actuated by a cylinder of 2 in. stroke, working wings 32 in. long. This machine would rise vertically 3 ft., the wings making about three beats during the flight, but the boiler limited the performance. It contained spirits of wine only sufficient for 38 seconds, and the apparatus was but a toy.

In 1871 *Prigent* designed the apparatus shown in fig. 15, which was evidently suggested by the dragon-fly; this is a favorite idea with aviators, who, as we have seen already, have proposed the combination of two pairs of wings over and over again. It was intended to be driven by steam, but although in that same year *Moy* had produced a steam-engine and boiler weighing but 27 lbs. per horse power, and *Stringfellow*, in 1868, has shown one claimed to weigh but 13 lbs. per horse power (both applied to aeroplanes), no attempt seems to have been made to experiment with *Prigent's* device. The fact is, that even the weight of the engines mentioned was too great, for it did not include the fuel and water, which for a non-con-

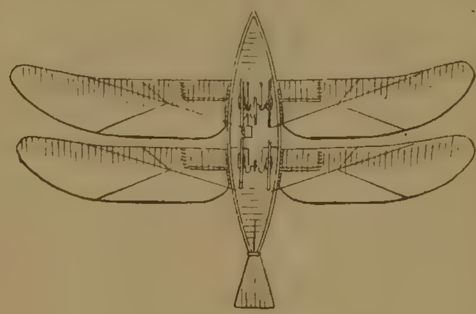


Fig. 15.—PRIGENT—1871.

densing steam-engine would amount to about 26 lbs. more horse power *per hour*, and this did not compare favorably with the motive power of birds. The pigeon, for instance, is known, both by dynamometric experiment and computation, to develop in ordinary flight from 160 to 425 foot-pounds of energy per minute for each pound of his weight, and as his pectoral muscles, which constitute *his* engine, generally compose $\frac{10}{43}$ of his weight, we have for the weight of *his* motor from

$$\frac{33.000 \times 10}{425 \times 43} = 18 \text{ lbs. to } \frac{33.000 \times 10}{160 \times 43} = 48 \text{ lbs.}$$

per horse power developed, including the fuel which enables him to fly for 10 to 12 hours at a stretch.

Hopeless, therefore, of accomplishing anything practical with steam-engines, experimenters with wings next turned their attention to springs or reservoirs of energy of various kinds, and with these they have succeeded in devising a number of toys which fly creditably for a few seconds. Clock springs were first tried, but they were

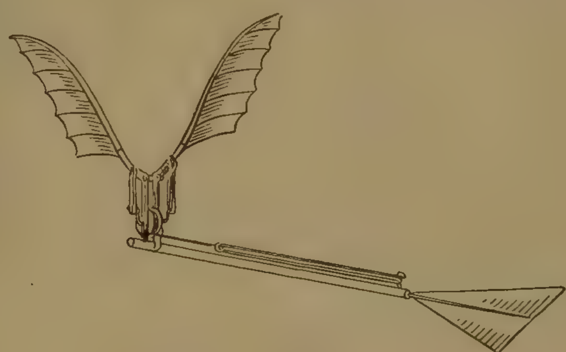


Fig. 16.—JOBERT—1871.

found to be unduly heavy, and in 1871 *Jobert* brought out his first mechanical bird, shown in fig. 16, driven by india-rubber in tension. The wings were arranged so as to change their plane automatically while flapping, in order to imitate the flexions of the natural wings, and the equilibrium was secured by adjusting the center of gravity so as to correspond with the center of pressure due to the angle of flight.

In 1872 *Pénaud*, who had already succeeded (1870 and 1871) in compassing flight with the superposed screws and with the aeroplane, which will be noticed hereafter, by the force of twisted rubber, applied the same motor to a mechanical bird, which is shown in fig. 17. The wings beat straight down, and the propulsion is obtained from the flexion of their outer edges produced by the reaction of the air. The bird is unable to rise from the ground, but upon being thrown off the hand it first descends some 2 ft., and then, having acquired the initial velocity needed for support, it flies for a distance of 50 ft. in 7 seconds, rising at the same time about 8 or 9 ft. above the point of departure, the equilibrium being perfectly maintained by the tail.

Simultaneously with this M. *Hureau de Villeneuve*, the permanent Secretary of the French Aeronautical Society, brought out his mechanical bird, which is shown in fig. 18. In this the plane of the wings is inclined at an angle

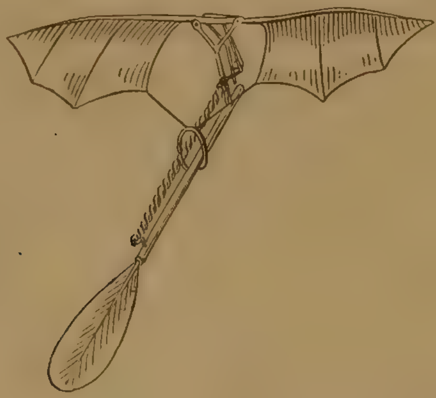


FIG. 17.—PÉNAUD—1872.

of 45°, and the power is obtained from twisted rubber. In consequence of the peculiar motion of the wings, this model was able to start direct from the ground, but owing

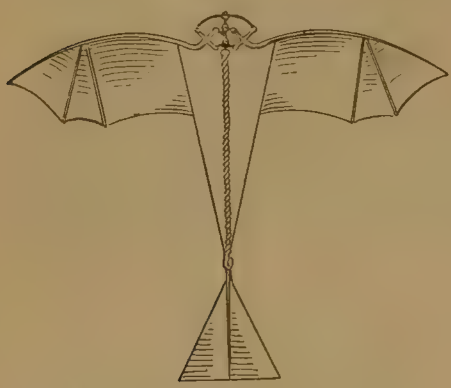


FIG. 18.—HUREAU DE VILLENEUVE—1872.

to the limited power of the rubber spring it only rose to the height of 4 ft., and then descended, forming a parachute. It was subsequently modified so that it would fly horizontally for a distance of 24 ft., at a velocity of 20 miles per hour.

M. *De Villeneuve* has been promoting aviation by flapping wings for the past 25 years. He has, first and last, designed something like 300 experimental models, so that his garret is a complete aviary of artificial birds. He built, some years ago, a huge steam bird on the model of a bat. Being aware that there was at that time no sufficiently light and reliable steam-engine with its boiler to furnish the power required, he placed only the engine on the bird, and connected it by a hose with a boiler on the ground. Upon trial, as soon as the steam was turned on the wings beat violently, and the apparatus rose with the inventor aboard. He grew nervous for fear that he would get beyond the length of his hose, and shut off steam suddenly, upon which the bird fell and smashed one of its wings. It is still in existence, and the inventor is awaiting the development of a very light motor in order to resume his experiments with this great bird, which is some 50 ft. across.

In 1872 M. *Jobert* brought out his second mechanical bird, shown in fig. 19. This is driven by twisted rubber, as being more manageable than rubber in tension, and consists of four wings beating alternately in pairs—as a horse trots—in order to produce continuous and uniform support and equilibrium, instead of the jerking motion observable in other apparatus. This flew fairly well, but a measurement of the foot-pounds developed and of the results obtained, in this as well as in the three other mechanical birds previously described, led to the inference that there was great waste of power, as compared with that of birds. This was attributed to the rigidity of the

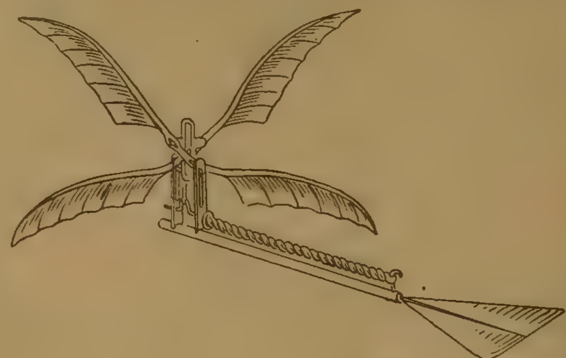


FIG. 19.—JOBERT—1872.

front edge of the wings in all these models, and accordingly in 1876 *Tatin* took the problem up again and succeeded, by a double eccentric working two levers connected to the front edge of the wing, in giving it a twist-

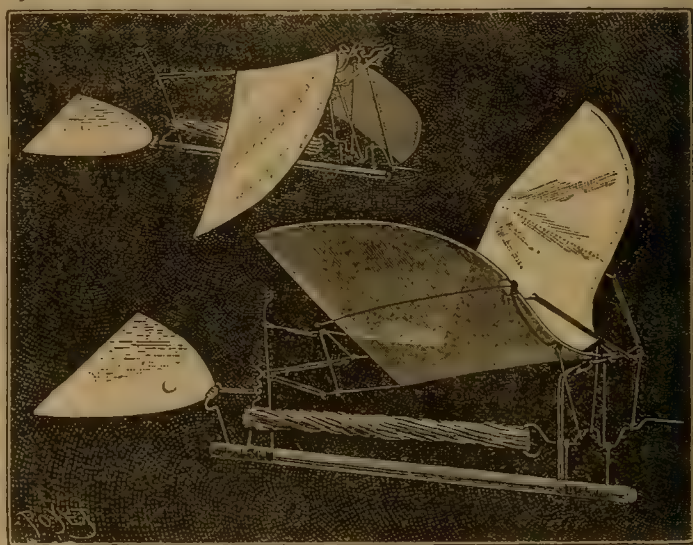


FIG. 20.—PICHANCOURT—1889.

ing motion similar to that of the bird. His apparatus flew some 65 ft., with rather less weight of rubber.

In 1889 *Pichancourt* carried the matter still further in the mechanical bird shown in fig. 20, in which there is a triple eccentric, each one actuating a lever fastened to a different point in the wings. His larger models, measuring 17½ in. from tip to tip of wings, and weighing 1½ oz., are said to have flown up to a height of 25 ft. and to a distance of 70 ft. against a slightly adverse wind.

Now here are no less than six artificial birds, each with a somewhat different wing-motion, and they all fly, when urged by the energy stored in twisted rubber. The question, therefore, occurs why practicable machines, to carry passengers, cannot be built by substituting some prime mover for the rubber; and the answer is that all these models are so wasteful of power that there is no motor known sufficiently light, in proportion to its energy, to take the place of the rubber. The best that seems to have been done with the latter was to obtain a flight of 7 seconds with flapping wings, and with the expenditure of energy at the rate of 600 foot-pounds per pound of twisted rubber. As there are 550 foot-pounds per second in a horse power, a primary motor, *with its supplies*, should in the same proportion weigh no more than:

$$\frac{600}{7 \times 550} = 6.4 \text{ lbs. per horse power,}$$

and there are none such known in practical operation.

Undeterred by this disheartening fact, M. *De Louvrié* designed, in 1877, the apparatus shown in fig. 21, which he calls the "Anthropornis," and which consists of a pair of wings, resembling those of the swallow, fastened to a hull mounted upon wheels, and intended to be actuated by a steam-engine or a petroleum motor. A spring is to contribute to the downward stroke, and is to be raised by the motor on the up stroke. M. *De Louvrié* is a veteran

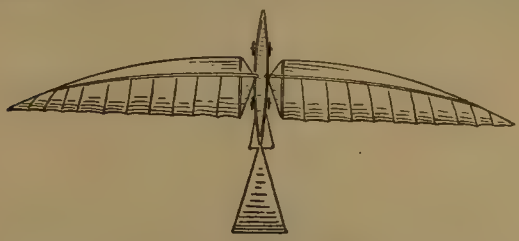


FIG. 21.—DE LOUVRIÉ—1877.

in promoting aviation, and his writings show a better understanding and firmer grasp of the question than most of those which have been published on this intricate subject. He had proposed, in 1863, a sort of kite-like flying machine, which will be noticed under the head of Aeroplanes, and it is said that, in 1888, he presented his latest views before a commission of the French Academy of Sciences, supplementing them with certain experiments, from which he drew the conclusion that an apparatus capable of carrying four passengers needed no more than 3 horse power to drive it at the rate of 67 miles per hour. It may be inferred that the French Commission was not convinced, from the fact that no action has been taken upon the proposal.

(TO BE CONTINUED.)

## HOW MANY CYLINDERS WILL IT PAY TO INTRODUCE IN THE MULTI-CYLINDER ENGINE?

By GEORGE I. ROCKWOOD.

THE records of scientifically conducted tests of double, triple and quadruple compound steam-engines in actual commercial service are rapidly multiplying, and have been given special prominence in the engineering journals of the past three or four years. Out of the wealth of data which they supply, one would think that an unquestionable theory might have been deduced for designers to follow; but the facts supplied stand in such curious and complicated relations to each other, that whatever has been written concerning the theory and design of the compound engine has been generally confused, partial, and fragmentary, and engineers of high degree hold various, and sometimes opposite, opinions as to the causes which conduce to the higher economy of the compound engine over that of the single cylinder engine.

The subject has, however, received one masterly and comprehensive treatment in the paper, entitled "The Philosophy of the Compound Engine," which was read in November, 1889, before the American Society of Mechanical Engineers, by Professor R. H. Thurston, of Cornell University. In this paper the method of inquiry into the causes of wastes of heat in the steam-engine is most searching and scientific, and it must be of the greatest assistance in all attempts at revealing the exact relations of the principles of economy involved. But viewing these relations in the clear light shed upon them by this most valuable paper, it may still be questioned whether some of the conclusions reached are ultimate or even correct. Is it true, for instance, that triple or quadruple-cylinder engines are theoretically necessary to secure the highest degree of economy in the use of steam? May it not rather be true that the use of more than two cylinders in series is positively disadvantageous?

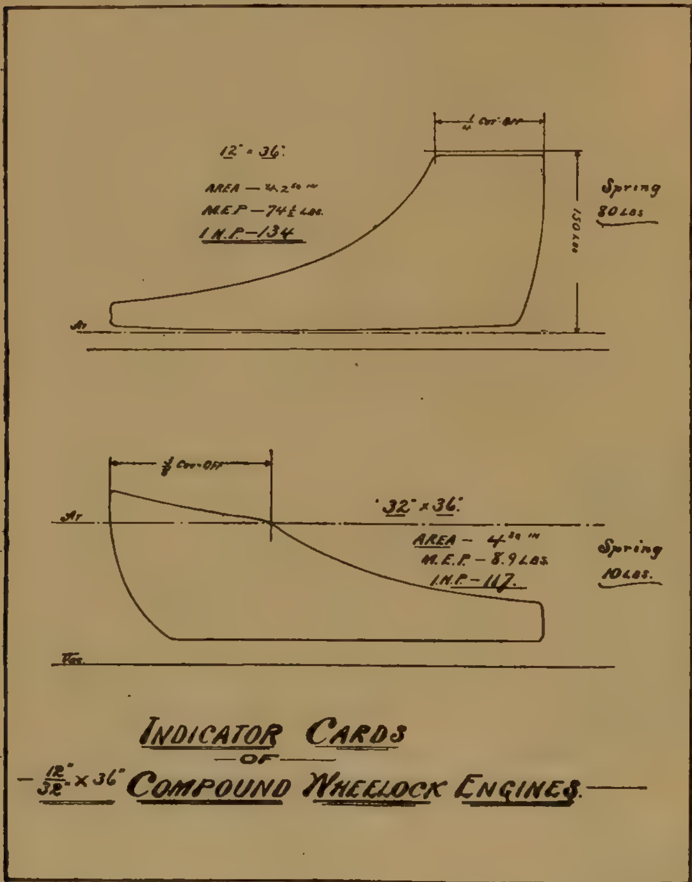
Professor Thurston proved very neatly that the introduction of one or of many cylinders between the low-pressure cylinder and the boiler does not affect the operation of the latter cylinder through cylinder condensation, however great that condensation may be, provided the operation of the added cylinders is effected by raising the steam pressure commensurately, leaving the low-pressure cylinder the same initial pressure as before; and he goes on to say: "The total waste by this form of loss is thus evidently measured in the case of the multi-cylinder engine by the *maximum waste in any one cylinder.*" The implication in this last sentence is, that waste of heat due to cylinder condensation does actually occur in every cylinder of the multi-cylinder engine. But if heat is absorbed in the walls of the high-pressure cylinder, and then transferred therefrom without being transformed into work in that cylinder, can it as yet be said to be wasted? True, it has passed through this cylinder without doing work, but so has all the remainder of the heat left in the steam at the instant of opening the exhaust port. How can it be a loss, since it is just as available for use in the succeeding cylinder as is this latter quantity of heat, and moreover, no heat is lost until it is deposited in the condenser? This is virtually what Professor Thurston says in the above statement that the quality of the steam delivered to the low-pressure cylinder is unaffected by the amount of cylinder condensation, be it much or little, which has occurred in the preceding cylinders. It must be the last cylinder alone, therefore, which wastes heat in this way, for its walls abstract a certain quantity of heat which is discharged directly into the condenser.

Now consider the difference between the conditions of steam distribution which would result in a given engine of four cylinders arranged on the tandem compound method, and those which would result in the same engine deprived of its two intermediate cylinders, the boiler pressure and the point of cut-off in the first cylinder not being varied in the two experiments. As the ratio of expansion in the compound engine is the quotient arising from dividing the volume of steam in the low-pressure cylinder at the instant of exhaust by the volume of steam in the high-pressure cylinder at the instant of closing the cut-off valve, the ratios of expansion in the two cases will be identical; and as, other things being equal, the efficiency of an engine varies with the ratio of expansion, the efficiencies in each case should also be identical, unless the amount of the internal wastes is affected by removing the two cylinders; but internal waste is shown to occur only in the low-pressure cylinder. Consequently, in order to prove that the two cylinders in series can be made to give an efficiency as great as three or more in series could give, it is only necessary to show that the same initial and terminal steam pressures and temperatures realized in the low-pressure cylinder of the multi-cylinder engine may be retained, although the two intermediate cylinders be removed from the engine.

It is probably well understood that with a given boiler pressure the average pressure in the receiver, between the high-pressure and low-pressure cylinders of a given double-compound engine, depends solely upon the relation of the volume of steam taken from the boiler by the high-pressure cylinder to the volume of steam taken from the receiver by the low-pressure cylinder, per stroke of the pistons. Should the low-pressure cylinder take a larger volume of steam, before cutting off, than the high-pressure cylinder delivers per stroke to the receiver, the average receiver pressure will be correspondingly lower than the terminal pressure in the high-pressure cylinder. If, therefore, the ratio of cylinder volumes in the double compound engine is the same as the ratio of the volumes of the high-pressure and low-pressure cylinders of a quadruple compound engine, and the points of cut-off in the low-pressure and high-pressure cylinders of each engine are alike, then, with the same boiler pressure in each case, the average pressures of the steam entering each low-pressure cylinder up to cut-off should also be the same, no matter how great the boiler pressure may be. But the extreme variations of the receiver pressure may be reduced as much as desired by increasing the dimensions of the receiver. So, by employing a receiver between the cylinders of the above-described double compound engine, of such proportions that the pressure of the steam delivered to the low-pressure cylinder shall be equal to the

pressure of the steam entering the low-pressure cylinder of the above-described quadruple compound engine, indicator cards taken from each low-pressure cylinder should be identical.

To recapitulate: In the multi-cylinder engine, loss of energy due to cylinder condensation occurs only in the last, or low-pressure cylinder. If the intermediate cylinders be cut out of the circuit, the amount of this loss will




not thereby be affected, provided the receiver capacity between the two remaining cylinders is sufficient to keep down the initial steam pressure in the last cylinder to the same intensity naturally occurring when the intermediate cylinders are in use. Therefore, more than two cylinders are theoretically *un*necessary to obtain the maximum possible economy in the use of steam.

Indicator cards are appended to show the character of the steam distribution in an engine composed simply of the high-pressure and low-pressure cylinders of a triple-expansion engine fitted with the Wheelock valve-gear. Much compression, together with a clean and instantaneous exhaust, is attained. In consequence of the excessively heavy unbalanced pressure in the high-pressure, two-cylinder compound engine, a very pronounced compression is needful to relieve the cut-off valves while opening, and is the only practical difference resulting from doing away with the intermediate cylinders. The Wheelock slide-valve has only $\frac{3}{16}$ in. lap, and it moves across this amount during the dwell of the piston at the end of the stroke.

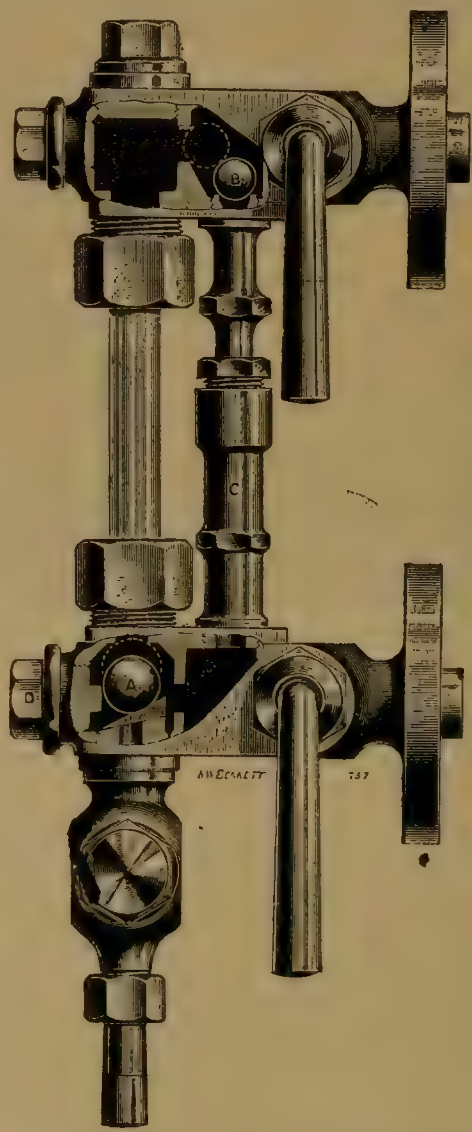
So much for hypothetical argument. But there is a very practical side to all this, for if it is true that more than two cylinders in series are unnecessary to secure to the owner of the engine the very best economy, then there has been a great deal of needless expense in equipping large steam plants of recent construction, as, most notably, in the case of the great plant of the West End Street Railroad, in Boston. The extra expense entailed by the addition of 13 intermediate cylinders, foundations, piping, etc., cannot come much under $60,000 or $70,000, and with the up-keep of all this extra machinery, this sum must bear a goodly percentage of compound interest, all to be added to the before-mentioned sum, and all a needless waste due to a supposed saving in—what? Initial cylinder condensation.

It seems hardly reasonable to doubt that if there be any virtue in the generally held theory, that the waste of the single-cylinder engine is chiefly due to absorption and transference of heat by its walls without transformation into work, a consistent application of that theory calls for no more than two cylinders to secure the maximum possible efficiency in the use of steam.

## AN ENGLISH SAFETY WATER GAUGE.

(From the London *Engineering*.)

THE breaking of a gauge glass of a boiler carrying high pressure is an accident that is always inconvenient and generally dangerous. No one would willingly face such an incident, even in a situation where it is possible to get away quickly, for a splash with scalding water is a most fearfully painful experience. But in a confined place, like




A SAFETY WATER GAUGE.

the foot-plate of a tramway locomotive, or the stoke hold of a torpedo boat, the failure of a glass has several times caused the death of the stoker, not to mention very numer-

ous injuries. A man need only be caught for a second or two in the rush of boiling water and steam to receive injuries rendering him incapable of flight, and causing him to sink down and be scalded to death.

Several attempts have been made to design gauge fittings that would close automatically upon the breaking of the glass, but without complete success. At length, however, Messrs. J. Hopkinson & Company, of Britannia Works, Huddersfield, have brought out the fitting shown in the annexed engraving, which completely answers all requirements, protecting the stokers perfectly, and being at the same time free from all danger of giving false indications. As will be seen, there is a valve both in the steam and in the water arm, and both these valves come to the seat in case of accident. The lower ball valve *A* is made so heavy that it cannot be held up against its seat by the pressure of the column of water in the boiler, and consequently there is no danger of the water being trapped in the glass and kept there to give a false indication. Further, the ball is of such a weight that it will not be carried up by the rolling of a vessel or the shaking of a locomotive. The ball *B* in the steam arm rests over the upper end of the supplemental tube *C*, as shown, except when it is forced forward against its seat, as shown in dotted lines. It also is safe from dislodgment by shaking.

When a glass breaks the water pressure in the lower arm throws the valve *A* against its seat and stops all escape at the lower end of the glass. At the same time the rush of water up the supplemental tube *C* lifts the valve *B*. This is then forced against its seat by the steam, and thus all escape is cut off instantaneously and certainly. A new glass can then be fitted with safety. Upon closing the cocks and removing the clearing screw *D* in front of the bottom arm, and a similar screw in that of the top arm, the valves will roll out of the gauge.

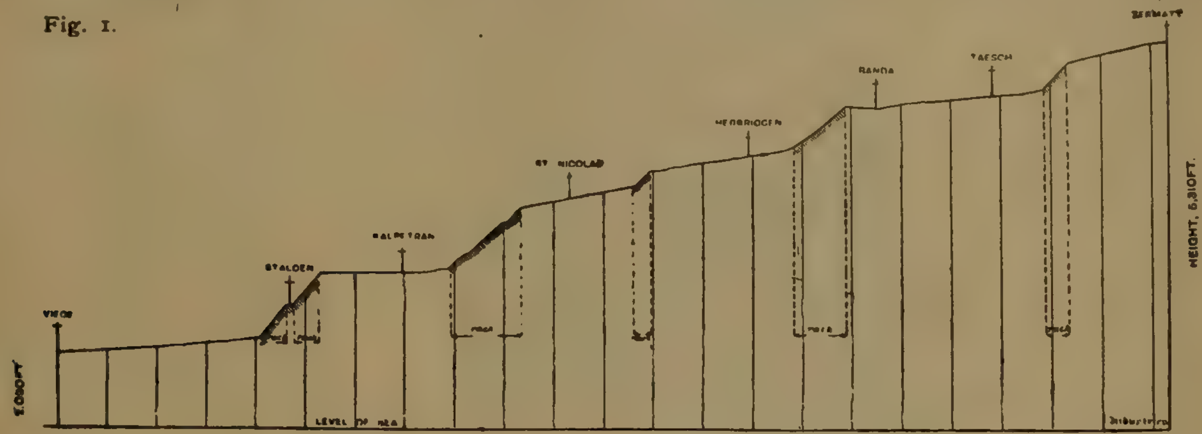
We are sure that our readers will recognize the merits of this gauge, and that those who are responsible for the safety of stokers will give it further consideration.

## THE VIÈGE-ZERMATT RAILROAD.

(Condensed from *Industries*.)

OF the great number of English tourists who every summer visit Switzerland, probably only a comparatively small percentage ever reach Zermatt, and yet the little mountain village, lying high up in the Pennine Alps, is, perhaps, one of the most favored spots in that most favored country. The reason is, however, not far to seek. From Viège, where the Zermatt Valley joins that of the Rhone, some 27 miles of road have to be traversed, for the first 12 of which there only exists a mule path. Travelers leaving the trains of the Jura-Simplon Railroad at Viège had still eight or nine hours' journey before them, for, owing to the mountainous nature of the paths and roads, progress was very slow. Once in Zermatt, however, the discomforts undergone are soon forgotten. For the geologist, the botanist, the mountaineer thirsting for a chance of distinguishing himself, and the invalid—either young or old—there are charms untold. From here the ascents of the Matterhorn, Monte Rosa, and Brietthorn are made, and the great glacier panorama of the Gornergrat is only an afternoon's walk distant. It is no wonder, therefore, that in spite of all hindrances more than 12,000 tourists have found their way thither during the last few years, and that Swiss engineering enterprise, stimulated by its previous successes, set itself the task of awakening the echoes of these Alpine solitudes with the shrill whistle of the locomotive.

Fig. 1.




PROFILE OF THE VIÈGE-ZERMATT RAILROAD.

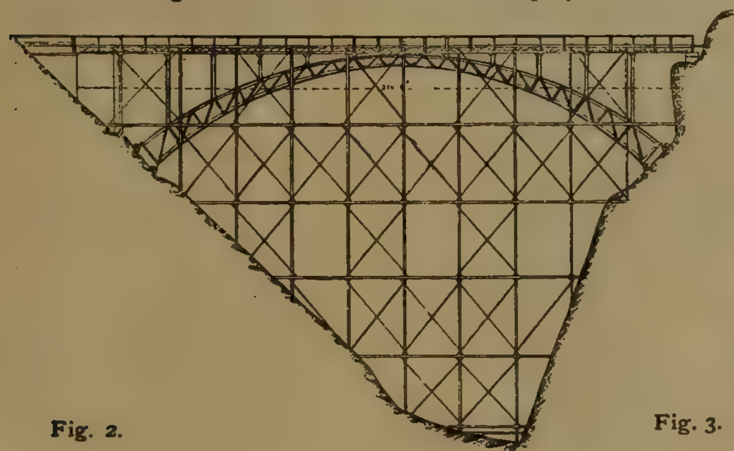


Fig. 2.

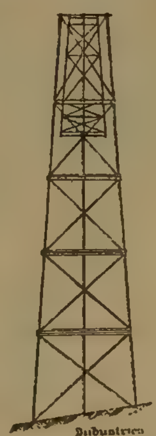


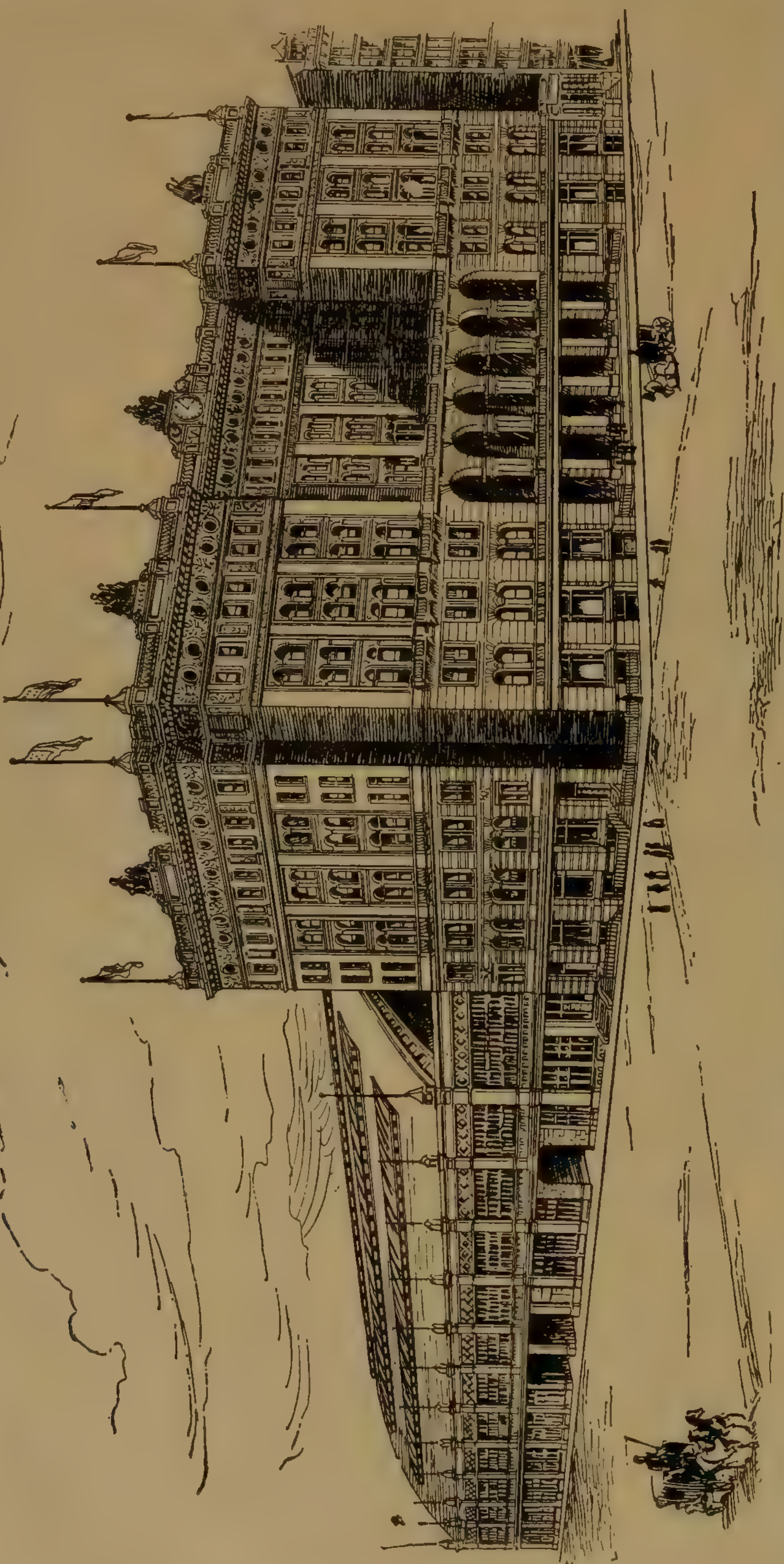
Fig. 3.

The building of the railroad was authorized in 1886, and the first survey made was for an ordinary adhesion line with maximum grades of 4.5 per cent. The estimated cost was so great that new surveys were made, and the final location provided for the introduction of sections of 10 and 12 per cent. grade, to be worked on the Abt rack-rail system.

The total length of the road is 21.99 miles, and the Zermatt terminus is 3,220 ft. higher than the starting point at Viège, the average rise being 146.5 ft. per mile. The manner in which the rise has been distributed and the grades arranged is shown in the accompanying profile, fig. 1, in which the rack-rail sections are shaded. The minimum radius of curvature is 197 ft.

The line is of 1-meter (39.37 in.) gauge. The rails are 49 lbs. to the yard, of steel, and are laid on steel ties of the Post or box type; these ties are of steel, and weigh 83 lbs. each. The rack-rail on the Abt system consists of two plates, each 1 in. thick for gradients of 10 per cent. and

upward, and ¾ in. thick for gradients between 7 per cent. and 10 per cent. The entrance points of the rack-rail, being carried on springs borne by each sleeper and connected by a link of 1 m. (39.37 in.) in length to the next rail, allow for such slight variations in position as will accommodate the pinions on the axles of the engine. This arrangement permits the engine to enter the rack without slowing down abnormally.



THE NEW TERMINAL STATION OF THE PHILADELPHIA & READING RAILROAD IN PHILADELPHIA.

The locomotives are adapted to both the ordinary and the rack-rail. They have four driving-wheels coupled, a pair of trailing-wheels behind the fire-box, side tanks and a coal-box on the rear end. The driving-wheels are 35.5 in. in diameter, and the trailing-wheels 23.6 in. These adhesion wheels are driven by outside cylinders 12.50 in. in diameter and 17.75 in. stroke. The driving-wheels are spaced 6 ft. 5.25 in. between centers, and the total wheel-base is 14 ft. 1.5 in. The boilers have a total heating surface of 705 sq. ft.; the grate area is 13 sq. ft., and the working pressure 170 lbs.

The pinions for working on the rack-rail are under the engine; there are two of them, connected by parallel rods. They are driven by two inside cylinders placed in the smoke-box, about on a line with the outside cylinders; they are 14.25 in. in diameter and 17.75 in. stroke. The pinions are spaced 36.75 in. between centers; they are 27.25 in. in diameter to the pitch-line, and the teeth are 4.75 in. pitch.

The locomotive thus really consists of two distinct engines, the outside cylinders working the driving-wheels on the adhesion line, and the inside cylinders being brought into use on the rack-rail line. Both outside and inside cylinders have the Walschaert valve gear. The locomotives were built by the Swiss Locomotive Machine Works at Winterthur.

The cars are of three kinds: second-class, third-class and open observation cars. They are all of the same size, weighing about 12 tons each, and carried on two four-wheel trucks. The second-class and observation cars can seat 48 passengers each, and the third-class cars 56. They are fitted with vacuum brakes and with special brakes working on the rack-rail. The locomotives have driver brakes.

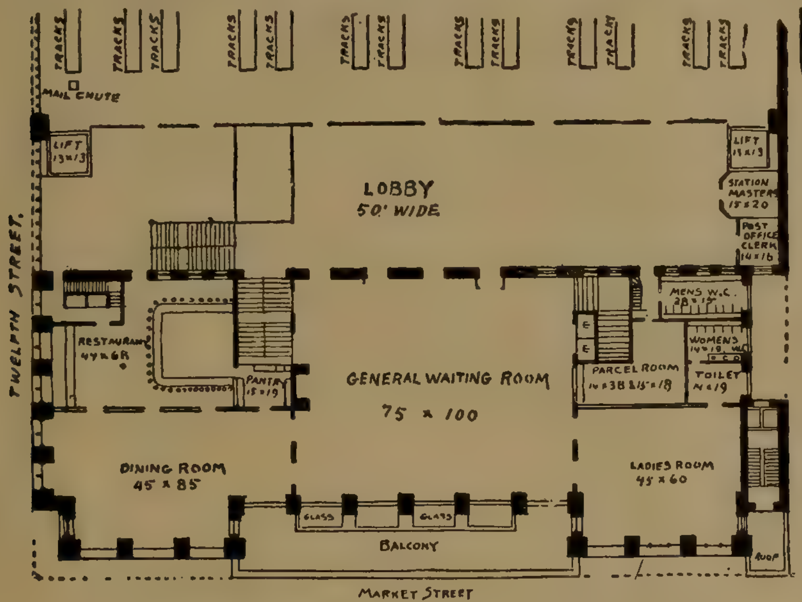
The special works required are not very heavy, as the adoption of the rack-rail and heavy grades permitted the line to follow the natural conformation of the valley. There are five short tunnels, with a total length of 784 ft. There are a number of small bridges, but the only large bridge is the Mühlbach Viaduct, a sketch of which is shown in figs. 2

and 3. This bridge spans a ravine, is 219 ft. long over all, and 148 ft. in height from the bottom of the valley to the rail. The span of the arch is 176 ft. The general construction is shown in the sketch.

This road was partly completed in 1890; it was opened to Zermatt in July last, and carried a large number of passengers this season. It is not operated in the winter. The cost complete, with a single track, was about $50,000 per mile.

## THE PHILADELPHIA & READING TERMINAL STATION.

THE new terminal station of the Philadelphia & Reading Railroad Company, in Philadelphia, is probably the most important structure of its kind now in progress in this country. It will replace the old passenger stations, and will, for the first time, give the Reading Company convenient and sufficient accommodations for its business. For the accompanying illustrations, which show a general




SECOND FLOOR PLAN P&R STATION 12TH & MARKET STS

view of the main building as it will appear when completed, and a plan of the main floor of the station, we are indebted to the Company.

The main building, which is situated at the corner of Twelfth and Market streets, in Philadelphia, is 266 ft. front on Market Street, 100 ft. deep and 132 ft. high from the pavement to the top of the cornice. It is divided into eight floors, and, as the illustration shows, is of a handsome and rather striking design of the Renaissance order. The material for the lower floors up to the balustrade which surmounts the entrance arches is of a pinkish granite. The upper stories will be of light-colored brick with terra-cotta trimmings.

As will be seen from the illustrations, the lower or ground floor, with the exception of the entrance to the station, which is on a level with the sidewalk, is a few steps below the street; and this long basement is given up to stores, of which there will be six on the Market Street front and one on Twelfth Street. Behind these and under the train-house are the cab-stands and approaches for baggage wagons in the rear of the main building.

On the first floor of the main building are the ticket offices, a large passenger lobby and the baggage rooms. On the corner of Twelfth and Market streets is the treasury department of the Company, and at the other Market Street corner the offices of the Treasurer of the Coal & Iron Company.

The second floor contains the general waiting-room, 100 × 75 ft., with the ladies' room, 44 × 56 ft., to the right, and the dining-room and restaurant to the left. These will be fitted up in the latest and most approved style. In front is a balcony overlooking Market Street, which will be a delightful spot in pleasant weather for persons who have time on their hands waiting for trains.

There is a half story between the second and third floors, which will contain the offices of the operating department of the Reading Terminal Company. The remaining floors will be used for the general offices, now located at No. 227 South Fourth Street. President McLeod's offices will be at the corner of Twelfth and Market streets, on the third floor, adjoining the Board rooms, reception-rooms, etc. The eighth floor will be used for storage and for mechanical apparatus for heating, lighting, etc., all of which will be of the most approved pattern.

The train-shed, which is rear of the main building, has the same width and extends through to Arch Street. The tracks are on a level with the second floor of the main building, and are entered by trains from the elevated structure which the Reading Terminal Company is now building. Filbert Street passes under this shed, and the basement under the train-house from Filbert Street north is occupied by the Market House, which the terminal was required to construct under its contract with the city. The train-house is wide enough to contain 13 tracks with the necessary platforms, and the tracks are of sufficient length to accommodate the longest train usual.

The building has been designed under the direct supervision of President McLeod, who furnished all the main features of the design, and has also paid careful attention to details. His object was to secure a desirable architectural effect with the greatest possible convenience in arrangement, and it is believed that he has succeeded.

Work is now being pushed on the station as fast as possible. The rear end of the train-house and the market-house will be completed during the winter, and it is expected that the building will be so far finished that trains can begin to use it by September next, although the entire structure will not be ready for occupancy before December, 1892.

Philadelphians and other travelers who are obliged to use the present very cramped and inconvenient station of the Company at Ninth and Green streets will appreciate highly the advantages to be gained by the change to the new building.

## THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. FORNEY.



(*Continued from page* 521)

### CHAPTER XIII.—(*Continued.*)

#### OBLIQUE PROJECTION OF A SPUR WHEEL.*

IN drawing a spur wheel or other object in an oblique position, with respect to the vertical plane of projection, it is necessary, in the first place, to lay down the elevation and plan as if it were parallel to that plane, as represented in figs. 348 and 349. Then transfer the plan to fig. 351, giving it the same inclination to a horizontal line which the wheel in the side view ought to have to a vertical plane. Assuming that the horizontal lines $A\ G$ and $H\ B$ pass through the center and axis of the wheel both in the parallel and oblique projections, figs. 348 and 350, the center of its front face in the latter position will be determined by the intersection of a perpendicular raised from the point $C'$, fig. 351, with that axis. Now it is obvious that if we take any point, as $a$ in fig. 348, the projection of that point in fig. 350 must be in the line $a\ a$, parallel to $A\ G$ and

* The elucidation of the method of drawing an oblique projection of a spur wheel, and the engravings illustrating it, are taken from the "Engineer and Machinists' Drawing-Book."

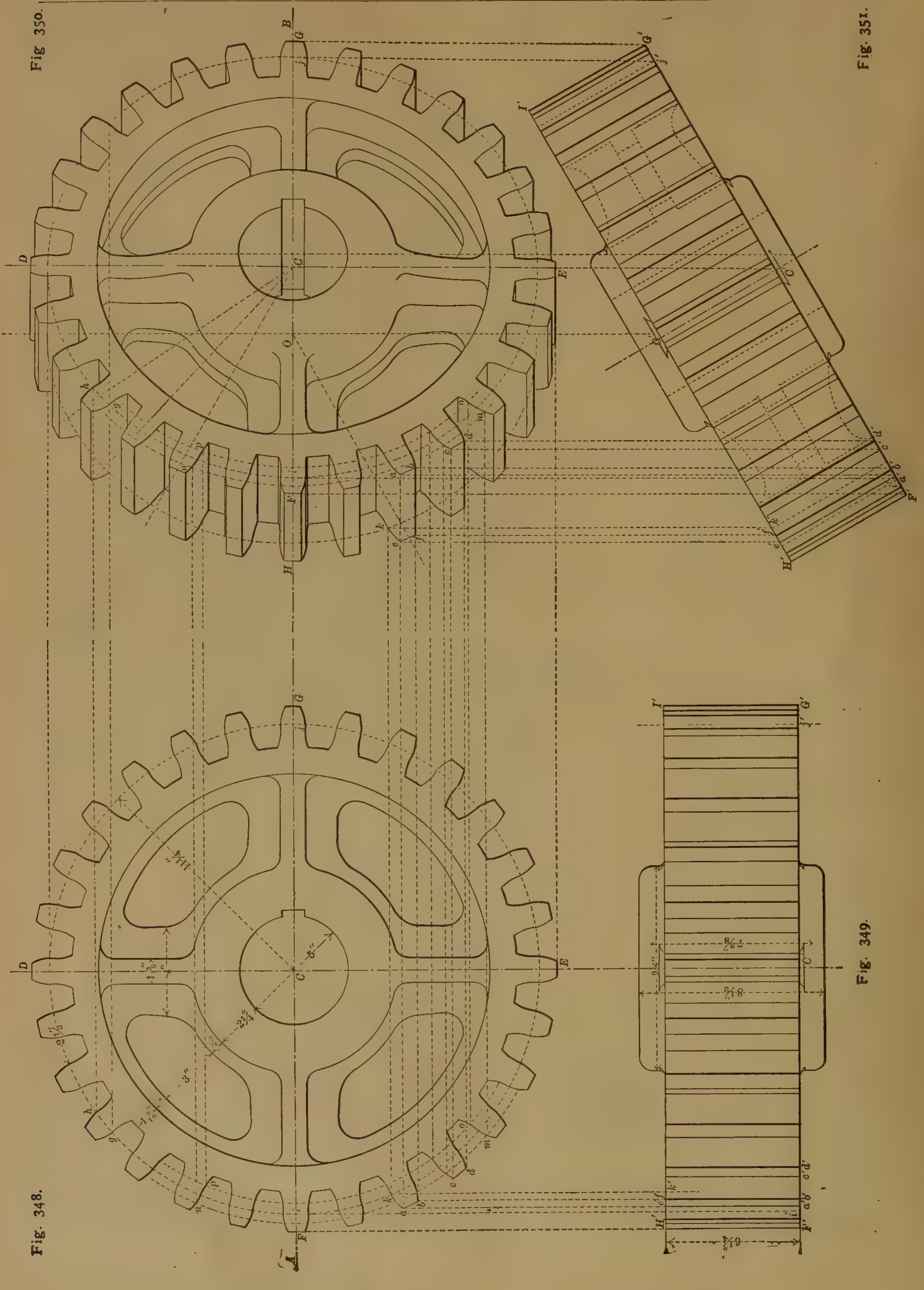


Fig. 350.

Fig. 351.

Fig. 348.

Fig. 349.

$H B$; and further, this point being projected at $a'$ in fig. 349 and transferred to fig. 351, that its projection in fig. 350 must be in the perpendicular $a' a$, figs. 350 and 351. Therefore the intersection of these two lines is the point required. Thus all the remaining points, $b$, $c$, $d$, etc., may be obtained by the intersections of the perpendiculars raised from the points $b'$, $c'$, $d'$, etc., fig. 351, respectively, with the horizontals drawn through the corresponding points in fig. 348. It will also be observed that since the points $e'$ and $f'$ in the further face of the wheel have their projections in $a$ and $b$, fig. 348, their oblique projections will be situated in the lines $a\ a$ and $b\ b$; but they are also at $e$ and $f$; consequently the lines $e\ a$ and $f\ b$, fig. 350, are the oblique projections of the edges $a'\ e'$ and $b'\ f'$, fig. 351. We have now to remark that all the circles which, in the rectangular elevation, fig. 348, been employed in the construction of this wheel, are projected in the oblique view into ellipses the length and position of whose axes may be determined without any difficulty; for since the planes $F'\ G'$, figs. 349 and 351, in which these circles are situated, are vertical, the major axes of all the ellipses in question will obviously be perpendicular to the line $H\ B$ and equal to the diameters of the circles of which they are respectively the projections; and the minor axes, representing the horizontal diameters, will all coincide with the line $H\ B$. Thus, to obtain the ellipse into which the pitch circle is projected, it is only necessary to set off upon the vertical $D\ E$, fig. 350, above and below the point $C$, the radius of the pitch circle, whose horizontal diameter $i\ j$ being at $i'\ j'$, fig. 351, is projected to $i\ j$, fig. 350; and thus, having obtained the major and minor axes, the ellipse in question may easily be constructed. The intersections of the horizontal lines $g\ g$, $h\ h$, etc., figs. 348 and 350, with this circle gives the thickness of the tooth $g\ h$ at the pitch line; and by projecting in the same manner the circles bounding the extremities and roots of the teeth, these points in each individual tooth may be determined by a similar process. But since, in cases where strict accuracy is required, a greater number of points is necessary for the construction of the curvature of the teeth, two additional circles, $n\ m$ and $p\ o$, may be drawn, fig. 348, and projected to fig. 350, where the corresponding points are indicated by the same letters.

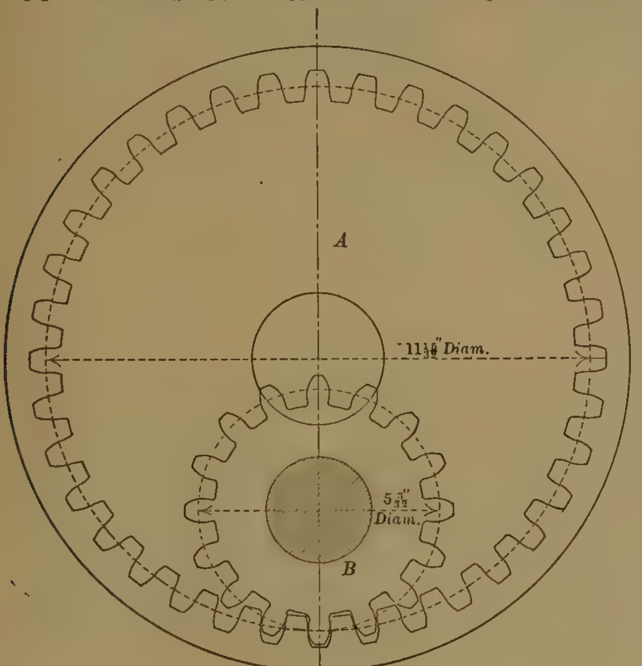



Fig. 352.

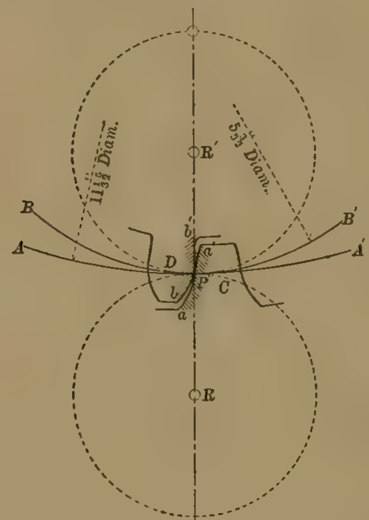
It is almost unnecessary to observe that the instructions we have given for the drawing of the anterior or front face $F'\ G'$ of the wheel are equally applicable to the posterior or back face $H'\ I'$, which is parallel to it, and in all respects the same; the common center of all the circles in it being $O'$, fig. 351, is projected to $O$ in fig. 350. Hence it will be easy to construct the ellipses representing these circles in the oblique projection, and consequently to determine the points $e$, $f$, $k$, etc., in the curvature of the teeth; observing that, as their center lines converge to $C$ in the front face, they all tend to $O$ in the remoter surface, which is, however, for the most part concealed by the former.

It would be superfluous to enter into any details regarding the construction of the oblique view of the rim, hub and arms, which are drawn upon precisely similar principles to those which have already been so fully explained.

### INTERNAL GEARS.

Fig. 352 represents a gear wheel, $A$, in which the pinion $B$ is within the circumference of the pitch circle. Such gears were formerly quite extensively used, but of late years they have come to be considered as clumsy contrivances, and are rarely used except in special mechanisms.*

Fig. 353.




The method of laying off cycloid teeth for such gears is as follows:

Let $A\ A'$, fig. 353, and $B\ B'$ be arcs of the pitch circles of a wheel with 36 teeth of 1 in. pitch, and of an internal geared pinion with 16 teeth, and $P$ the pitch-point; $C$ a tooth belonging to the wheel, and $D$ one on the pinion. The flank $P\ a$ of the tooth $C$ works on the face $P\ b$ of the tooth $D$. The outline of the flank $P\ a$ is an epicycloid described by the rolling of a generating circle, $R$, on the pitch circle $A\ A'$ of the wheel; and the outline of the face $P\ b$ of the tooth of the wheel is also an epicycloid, described by the rolling of $R$ on the pitch circle $B\ B'$ of the pinion. The face $P\ a'$ of the wheel tooth $C$ works with the flank $P\ b'$ of the pinion tooth $D$. The outline of $P\ a'$ is a hypocycloid, described by a generating circle, $R'$, rolling inside of the pitch circle $A\ A'$ of the wheel; and the flank $P\ b'$ is described by the rolling of $R'$ inside of the pitch circle $B\ B'$ of the pinion. As the diameter of $R'$ is in this case half that of the pitch circle of the pinion, $P\ b'$ is a straight line.†

### BEVEL GEARS.

It has been explained that the action of spur wheels in relation to each other is similar to that of two revolving cylinders whose surfaces are in contact and whose axes are parallel. The

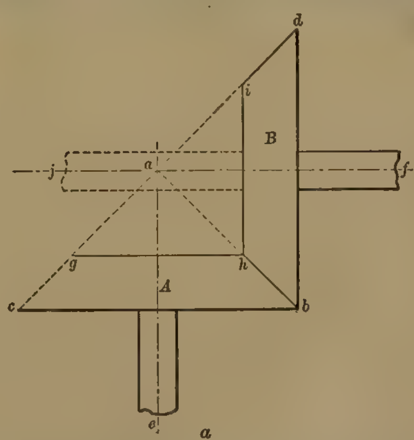



Fig. 354.

cylindrical surfaces which are in contact, and whose circular outlines form the pitch circles, may be called the [illegible]

* I. Howard Cromwell's "Treatise on Toothed Gearing."
† From Unwin's "Elements of Machine Design."

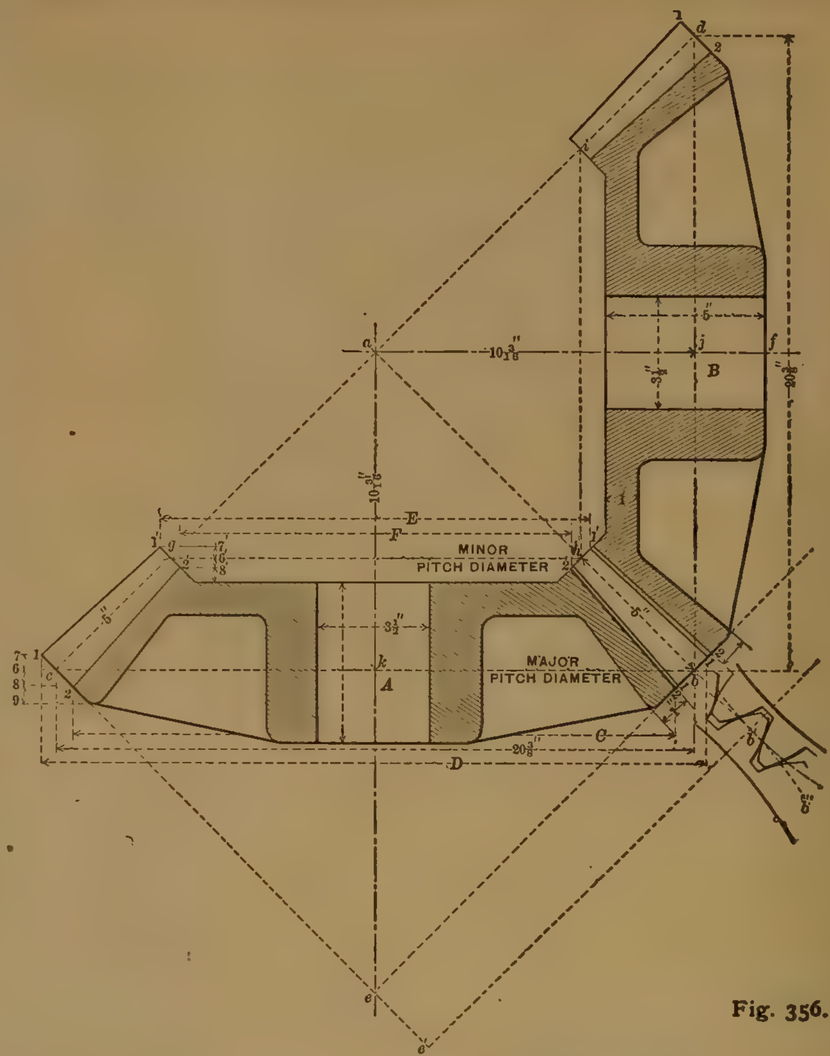



Fig. 356.

*cylinders* or *pitch surfaces*. These can revolve in contact with each other without sliding. If the axes of gear wheels are not parallel and would intersect each other if extended sufficiently, then the pitch surfaces must be cones in order to revolve in contact without sliding. This is shown in fig. 354, in which *a b c* and *a b d* are two cones in contact on the line *a b*; *a e* and *a f* being their axes. It is evident that two such cones can revolve in contact with each other without sliding. Usually the axes of bevel wheels are at right angles to each other, but it will make no difference in their action if their angle of inclination is not a right angle, as shown in fig. 355. Usually the pitch surfaces of bevel wheels, called *primitive* or *pitch cones*, consist of parts only or frustrums of cones. Thus in figs. 354 and 355 the conical surfaces of the parts *c g h b* and *b h i d* would form the pitch surfaces; the portions *a g h* and *a i h* of the cones are removed so that either of the shafts, as *j f*, fig. 355, may be extended in front of one of the wheels without coming in contact with the wheel *A*. It will also be seen that if the teeth which are formed on the pitch cones were extended near to their vertices at *a*, that the teeth would be too weak to stand the service required of them. The vertices of the cones, as shown in the figures, coincide, and are drawn from *a*, the intersection of the axes *a e* and *a f* of the two wheels.

In estimating the velocity ratio of bevel wheels, any two contiguous diameters, as *c b* and *b d* or *k l* and *l m*, fig. 355, of the primitive cones may be taken, but conveniently the largest pitch diameters, as *c b* and *b d*, are usually spoken of as the diameters of the wheel and pinion. Bevel wheels which are of the same diameter are often called *miter wheels*.

The method of laying off a pair of such wheels will first be described. The positions of the axes of the wheels being known—in this case at right angles to each other—their center lines *a f* and *a e*, fig. 356, are drawn. The number of teeth—32—and the pitch—2 in.—being known, a simple calculation gives the diameter of the pitch circles at $20\frac{3}{8}$ in. From *a*, the point of intersection of the axes of the two wheels, lay off on *a f* and *a e* distances *a j* and *a k*, each = to $10\frac{3}{16}$ in., or half the pitch diameter. Through the points *j* and *k* thus laid down, draw lines *c b* and *d b* perpendicular to *a f* and *a e*, and from *j* and *k* lay off distances *j d*, *j b*, *k b* and *k c*, each equal to half the diameter of the pitch circle. Then from *c*, *b* and *d* draw lines to *a*; *c a b* and *b a d* will then be the primitive or pitch cones for the two wheels. The teeth must be formed on these cones in somewhat the same way as teeth are constructed for spur wheels on the primitive cylinder of

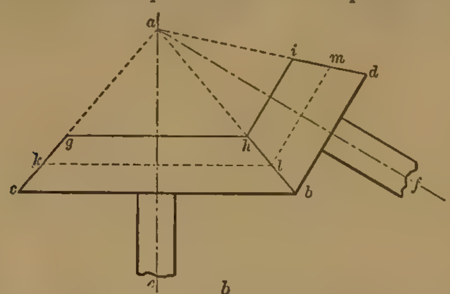


Fig. 355.

which the pitch circle is the outline. There will be the difference, however, that while the sides and the tops and bottoms of the teeth of spur wheels are parallel, those of bevel wheels will converge to the vertex of the cone on which they are formed.

In laying out two miter wheels, as shown in fig. 356, they are represented in section, and are supposed to be cut by a plane passing through their axes. This mode of representation has been adopted for the purpose of enabling us with greater facility to arrive at the true form of the exterior extremities of the teeth, and to show the mode of deriving from them the general form.

To lay off the teeth, first draw lines through *c*, *b* and *d* perpendicular to *c a*, *b a* and *d a*, and extend these lines so as to intersect *a e* and *a f*.* From *c*, *b* and *d* lay off on *c a*, *b a* and *d a* the distances *c g*, *b h* and *d i* = to the length of the teeth, in this case = $2\frac{1}{2}$ times the pitch, and through *g h* and *i* draw other lines perpendicular to the pitch surfaces. From *c*, *b* and *d* set off distances *c* 1, *b* 1 and *d* 1 = to the depth from the pitch circle to the tip of the tooth; and also lay off *c* 2, *b* 2 and *d* 2 = the depth from the pitch circle to the base of tooth. From the points 1, 1, 1 and 2, 2, 2 draw lines converging to the vertex *a* of the two cones. These lines between *c* and *g*, *b* and *c*, *d* and *i* will then represent the outlines of the teeth. The thickness of the rim and of the plate or arms are laid off of the same proportions as for spur wheels.

It has been explained that the largest pitch diameters, as *c b* and *d b*, are usually assumed to be the diameters of the wheels. By connecting the points *g* and *h* or *h* and *i*, fig. 356, we will have another pitch diameter which will be useful in laying out different views of the wheels. The first or larger diameter, *e b*, is called the *major pitch diameter*, and its corresponding circumference the *major pitch circle*; the second or smaller one, *g h*, is called the *minor pitch diameter*, and its circumference the *minor pitch circle*.

In drawing a plan and side view of one of the wheels which is represented in section in fig. 356, first draw a center line, *m o a e*, figs. 357 and 358. Then from *o* as a center and a radius equal to half the major pitch diameter, draw the major pitch circle *p q r s*, fig. 357, and from the same center and a radius equal to half the minor pitch diameter, draw the minor pitch circle *t u v w*. Subdivide the major pitch circle into the required number of equal divisions for the teeth—in this case 32. Take one-half the diameter *D* in fig. 356, measured over the tips 1 1 of the teeth, as a radius, and with it draw a circle from *o*, in fig. 357, outside the major pitch circle; and with another radius = one-half of *C*, fig. 356, the diameter at the roots of the teeth, draw

* To save room in the engraving, the intersection with *a f* is not shown.

another circle from $o$ in fig. 357 inside of the major pitch circle. These two circles will define the limits of the outer tips and roots of the teeth in the plan. With one-half the minor diameters $E$ and $F$ measured over the inner tips and roots of the teeth in fig. 356 draw other circles inside and outside of the minor pitch circle in fig. 357.

In order to lay out the forms of the teeth it will be supposed that the lines drawn through $b$ and $c$, fig. 356, perpendicular to

Fig. 357.

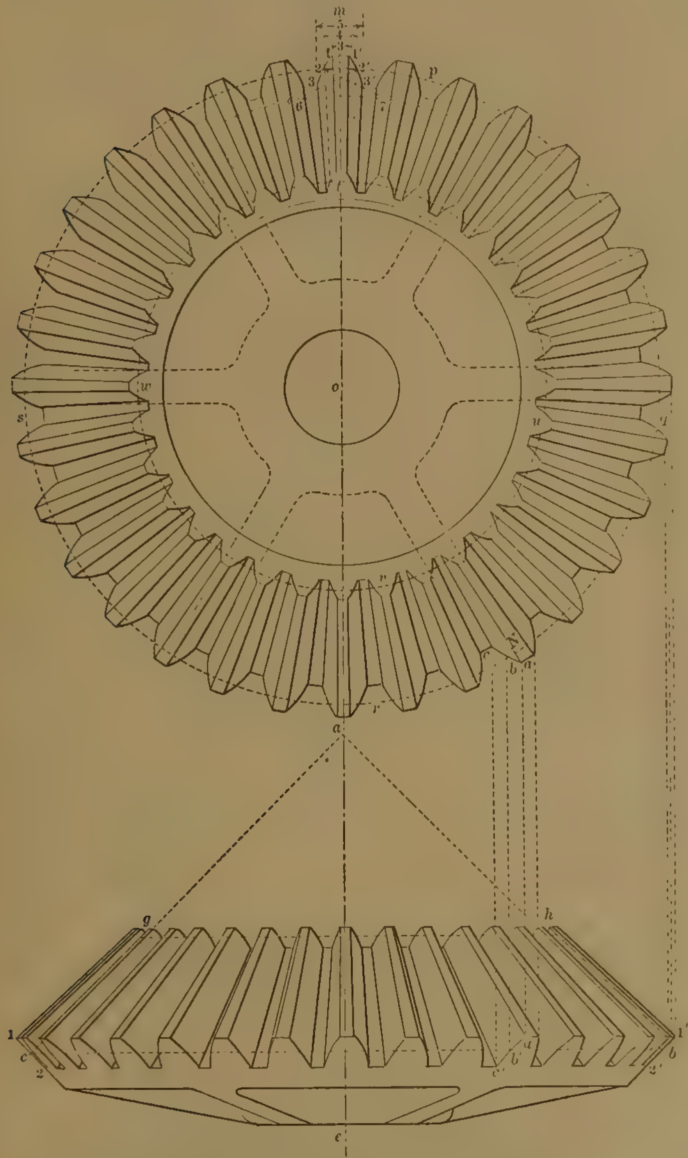


Fig. 358.

the pitch lines $a$ $b$ and $a$ $c$ are extended to $e$; $c$ $e$ $b$ then represents what is called a *tangent cone*, on the surface of which at $c$ and $b$ the teeth are laid off. As explained in Chapter XIII, if the surface or envelop of a cone is spread out flat it will be a sector of a circle, whose radius is equal to the length $e$ $b$ of the side of the cone. In order, therefore, to find the form and dimensions of the teeth, we must conceive a portion of the surface of the cone $b$ $e$ $c$ to be developed or spread out upon a plain surface, for which purpose let the line $e$ $b$ be supposed to be moved parallel to itself to $e'$ $b'$ or to any convenient distance beyond the figure, and with $e'$ $b'$ as a radius describe an arc $b$ $b'$ $b''$ of a circle, and from a center on $e'$ $b'$ extended; and the wheels being each of the same diameter—with the same radius—describe another arc tangent to $b$ $b'$ $b''$. These will be arcs of pitch circles upon which the operation of setting out and drawing the curvature of the teeth is to be performed precisely as in the case of spur gearing.* In the present instance involute teeth have been drawn, but cycloidal teeth may be used.

* "Engineer and Machinists' Drawing-Book."

Then from the points of division for the teeth on the major pitch circle in fig. 357 lay off one-half the thickness of the teeth on each side. Through one of the points of division draw a center line, as $m$ $o$. From fig. 356 take one-half the width of the tip of the tooth, as shown at $b'$, and lay it off each way from the center line $m$ $o$, fig. 357, on the circle outside of the major pitch circle. From fig. 356 take one-half the width of the tooth at its root or base, and in the same way set it off from $m$ $o$, fig. 357, on the circle which has been drawn inside of the major pitch circle. This then gives three points, 1, 2, 3 and 1′, 2′, 3′ in the outline of each side of the tooth, as shown in the plan. From these find centers 6 and 7 of arcs of circles which will each pass through three of the points. Draw a circle of centers 6 7 through the centers of the arcs; then with the radius of the arcs thus found, and from centers located in the circle of centers, similar arcs may be drawn through the points on the pitch circle, which represent the thickness of the teeth, to show the outlines of the outer ends of the teeth in the plan. Having done this, radial lines should be drawn from the corners 1, 1′ and 3, 3′ of the outer tips and roots of the teeth toward the center $o$ and to the circles within and without the minor pitch circle $t$ $u$ $v$ $w$. These lines will represent the corners of the teeth in the plan. From 2 and 2′ on the major pitch circle draw radial pencil lines toward $o$, intersecting the minor pitch circle at $t$. The intersections of the radial lines drawn from 1, 1, with the circle outside of the minor pitch circle at $t$, will give the width of the tip of the tooth at its inner end. The intersection of the lines drawn from 2 2′ with the minor pitch circle will give the width of the inner end of the tooth on the minor pitch circle, and the intersection of the lines drawn from 3 3′ with the circle inside of the minor pitch circle will give the width of the inner end of the tooth at its root. These three intersections will give three points in the outline of the inner end of the tooth through which arcs can be drawn in the same way as already explained for the outer end.

Fig. 359.

For the side view, fig. 358, of the wheel extend the center line $m$ $a$ to $e$, and lay down the major pitch diameter $c$ $b$ and pitch cone $c$ $a$ $b$, as already explained. Measure off on $c$ $a$ and $b$ $a$ the length $c$ $g$ and $b$ $h$ of the teeth, and draw the minor pitch diameter $g$ $h$. Then from fig. 356 take the vertical distance 6 7 of the outside end of the tip of the tooth above the pitch diameter $c$ $b$ and lay it off above $c$ $b$ in fig. 358, and draw a pencil line, 1 1′, parallel to $c$ $b$. Also take the vertical distance 6 8 of the root of the tooth below the pitch diameter from fig. 356, and draw another pencil line, 2 2′, in fig. 358, parallel to $c$ $b$ at the required distance below it. Proceed in the same way for the smaller ends of the teeth, and draw lines parallel to $g$ $h$ to represent the tips and roots at that end. Then from each of the teeth shown in the lower half of fig. 357 project lines, as, for example, $a$ $a'$, from the corners of the outer ends of the tips to the line 1 1′. The intersections at $a'$ will define the position of the corner of the tip of the tooth in the side view. Then from $b$, fig. 357, the intersection of the major pitch circle with the side of the tooth, draw another line, $b$ $b'$, intersecting the pitch diameter $c$ $b$ at $b'$ in fig. 358. Draw a similar line from $c$, the root of the tooth in fig. 357, to the line 2 2′ in fig 358, intersecting it at $c'$. Then $a'$ $b'$ $c'$ will be three points in the outline of the tooth through which an arc of a circle or other curve may be drawn which will represent the outline of the end of the tooth. Proceed in the same way for each tooth and mark the points, and then draw curves through these points with a pencil by hand. These may then be inked in most conveniently with the aid of an irregular curved template similar to that shown by fig. 359, which can be adjusted to the curves.

Having laid down the points representing the angles of the

outer ends of the teeth, converging lines should be drawn from them toward the vertex *a*, fig. 358, and intersecting the lines drawn parallel to *g h*, which define the tips and roots of the small ends of the teeth. The curves representing the small ends are laid down in the same way as described for the large ends.

TO BE CONTINUED.

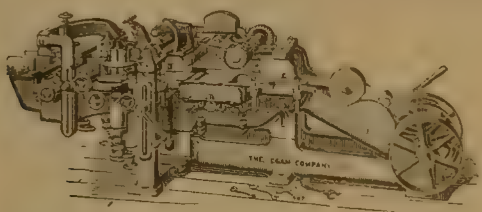
# Manufactures.

## A Heavy Standard Molder.

THE accompanying illustration represents an extra heavy standard 12-in. molder made by the Egan Company. This machine, it is claimed, is equal in capacity to any inside molder, and has all the advantages of an outside molder in setting up for heavy or light work. It can be used as a timber dresser also, and will dress up 8 × 8-in. timbers on all four sides at one operation. It is especially adapted for heavy building material, car work and the like.

The frame is very heavy, well braced, with ample floor space. It is made extra long, so that the belts have great pulling capacity and every advantage and convenience for easy running. The spindles are made of the best cast steel, large in diameter, and run in extra long self-oiling boxes, lined with genuine Babbitt metal. The patent outside bearing is of the latest improved construction. It goes to the floor and is braced by a solid projection from the base of the frame. No bolts or outside boxes have to be taken off to raise and lower the bed.

The side heads, with their spindles, raise and lower with the table, and both inside and outside spindles are adjustable vertically and horizontally, while in operation, by hand wheels on the front side below the bed. The under head is also adjustable




NEW EXTRA HEAVY 12-IN. STANDARD MOLDER.

laterally. These are great improvements on molders, and will be appreciated by all first-class operators. There are chip breakers to every head, and in this there is a marked advantage, as there can be no tearing on any of the heads, the way these improvements are rigged.

The patent bonnet is adjustable to or from the head, independent of the adjustable shoe, which can be brought clear under the knife. The bonnet swivels on a stud and can be swung clear out of the way, giving free access to the knives. The pressure foot for the lower head is a cored arm, projecting from the back of the frame and supported at the front of the bed, making a very stiff and reliable pressure foot, holding the work down solid to the bed, thereby doing perfect work on the lower cylinder.

The feed is extra powerful, and consists of four rolls, two in the bed and two above, all driven by powerful gearing, and the expansion for driving the lower rolls is very perfect. There are two feeds on the machine. The upper feed spindles are hung on links in such a manner that the feed rolls raise up parallel, giving the feed rolls a full bearing on the board the entire width of the piece. By an improved system of weighting, the feed rolls can be instantly raised up, allowing the operator to slip the board back.

Further information can be obtained from the builders, the Egan Company, Nos. 194–214 Front Street, Cincinnati, Ohio.

## Baltimore Notes.

SURVEYS have been made and preparations are being made for the construction of the Washington & Chesapeake Beach Railroad. The road will be 30 miles long, single track, standard gauge, and will run from Washington to a point on Chesapeake Bay near Fair Haven.

WORK on the new electric line to Curtis Bay, to be known as the South Baltimore & Curtis Bay Railroad, will be commenced January 1, 1892, and the road put into operation by March, connecting with the Blue Line horse cars, which will be cabled. The power and car houses will be built by the Ryan & McDonald Company and the South Baltimore Car Works. A 300-H.P. steam plant will be put in the power house, which is to consist of one story about 50 × 90 ft. The building will be constructed of fireproof brick, but the car house will be of iron, 60 × 150 ft. The contract for building the road-bed, etc., has been awarded to Rutherford & Seddon.

THE Mt. Clare Shops, Baltimore & Ohio Railroad, have just received an order for the construction of 31 standard four-wheel caboose cars.

THE Baltimore & Ohio Railroad will run its trains into the Wisconsin Central Station, at Chicago, on December 1.

WORK on the new stone bridge at North Avenue and Jones Falls, Baltimore, Md., will soon commence. The grade of the avenue will be raised several feet on both sides of the bridge. The cost will be about $400,000.

## General Notes.

THE Baldwin Locomotive Works are building five decapod freight engines for the New York, Lake Erie & Western Railroad. These engines will weigh 177,000 lbs. each, and will be of the Vauclain compound type, with cylinders 16 in. and 27 in. in diameter and 28 in. stroke.

AT the shops of William Sellers & Company, in Philadelphia, the first of the new gun lathes for the Washington Navy Yard is nearly completed. This lathe is intended to do the fitting work on the 16-in. guns, will occupy a space 133 ft. long, 12 ft. high and 10 ft. 6 in. wide. It will weigh 500,000 lbs. These shops are also building seven other lathes for the Washington Yard, only slightly smaller.

THE Schenectady Locomotive Works are building 50 locomotives for the New York Central & Hudson River Railroad. Of these 20 are eight-wheel passenger engines, 19 are mogul freight engines, and 11 are suburban engines of the type described and illustrated in the JOURNAL for September last.

THE Bucyrus Steam Stovel & Dredge Company is making arrangements to build extensive works in Milwaukee. The present plant is not sufficient for the growing business, and larger shops are needed. Those in Milwaukee will have plenty of room.

THE Cedar Point Furnace of Witherbee, Sherman & Company, at Port Henry, N. Y., will soon go into blast.

THE Waring Sewer Pipe Company, Newport, R. I., is now manufacturing sewer pipe of *beton* made of oval form, so as to give full scouring effect to a stream of water. It is made in two sections, an invert with a broad, flat base, and walls rising nearly to the whole height of the pipe, forming a channel open at the top; and an arched cover, to be applied after the invert has been laid and cemented.

THE Wheeler Condenser & Engineering Company, New York, has bought the entire plant and business of the Colwell Iron Works, including the shops at Carteret, N. J., the drawings, patterns, etc.; also the condenser business and patents of F. M. Wheeler. The officers of the company are: C. H. Wheeler, President; F. M. Wheeler, Vice-President; W. H. Hampton, Secretary; A. Vanderbilt, Treasurer; William Porter, Superintendent.

THE work on the new bridge over the Allegheny River at Pittsburgh is progressing well. The Union Bridge Company is contractor, and the work is in progress at the shops at Athens, Pa., the steel being furnished by Carnegie, Phipps & Company. The bridge will have two spans, each 445 ft. long, of the bowstring girder type, and a deck plate girder span of 41½ ft. over the Pittsburgh & Western Railroad on the Allegheny side. The height of the large truss at the center is 79½ ft. clear, and the width of the roadway will be 40 ft., accommodating four lines of track, two to be used for street-car traffic and two for wagon traffic; the two sidewalks will be 9 ft. each in the clear, protected by hand railings.

THE Continental Iron Works, Brooklyn, N. Y., report an increasing demand for corrugated flues for boiler furnaces, and the works are very busy. In this connection it may be noted that at a recent meeting the Board of Supervising Inspectors of Steam Vessels raised the constant for corrugated furnaces from 12,500 to 14,000, allowing an increase of about 12 per cent. over the old formula in steam pressure on boilers with corrugated furnaces.

IN the United States Circuit Court, in Chicago, recently, in the case of Pettibone & Mulliken against Arthur L. Stanford, Judge Gresham decided in favor of the defendant, holding that his track-jack as made and sold was not an infringement of plaintiff's patents.

THE Ranken & Fritsch Foundry & Machine Company has recently made extensive improvements in its works in St. Louis, and has added a number of tools to its plant. Mr. Joseph H. Springer, late of the Niles Tool Works, is now General Manager of this company, succeeding the late Mr. Bruno Fritsch.

THE iron roof for the store house which the United States Government is building at Willett's Point, L. I., will be furnished by the Berlin Iron Bridge Co., of East Berlin, Conn.

A NEW suspension bridge is to be built in Golden Gate Park, San Francisco, over a depressed roadway. The total length will be 140 ft., with a clear span between towers of 60 ft. The towers will be of steel, each consisting of a group of eight columns. The cables will be of steel wire, and will be 2½ in. in diameter. The floor will rest on 12-in. steel beams suspended from the cables by iron rods, and braced together transversely. The iron side-railings are so designed as to act as stiffening trusses. The roadway will be 23 feet. wide, and will have a camber of 3 ft.; the height will be 17 ft. above the lower road at the center.

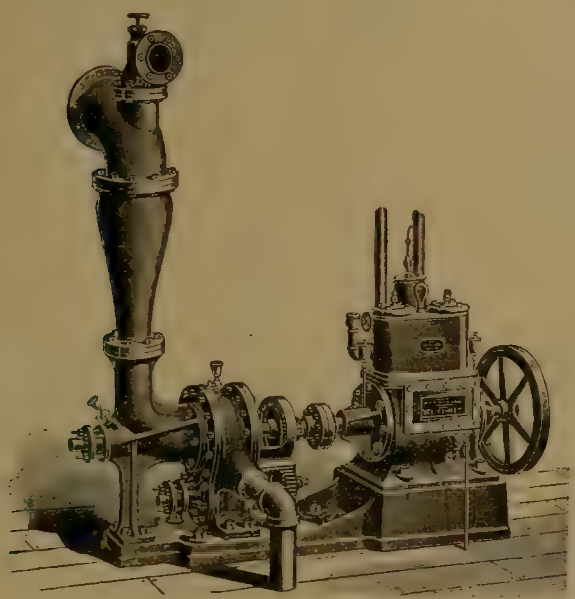
## Car Heater Patents.

THE Board of Examiners of the Patent Office decided, on October 28, four important interferences, covering practically the basic principles of car heating by disk, coil or other drums. The result of these decisions will be to limit the use of the steam drum or jacket of any form in connection with a hot-water circulating system in a car, to the Consolidated, the Safety and the Gold companies. The patents which will issue under the decisions are granted, one to Henry R. Towne and three to James F. McElroy. This does not affect in any way the commingler, in which steam is noiselessly injected into the water of circulation in a car.

## Condensers.

THE use of condensing engines in ordinary work in this country is not very common, the great majority of stationary engines being non-condensing. There are many reasons for this which can hardly be given here in full.

In general it may be stated that only under the exceptionally favorable conditions of a properly proportioned condenser of an economical type, an engine not too large for the work, and



AN IMPROVED CONDENSER.

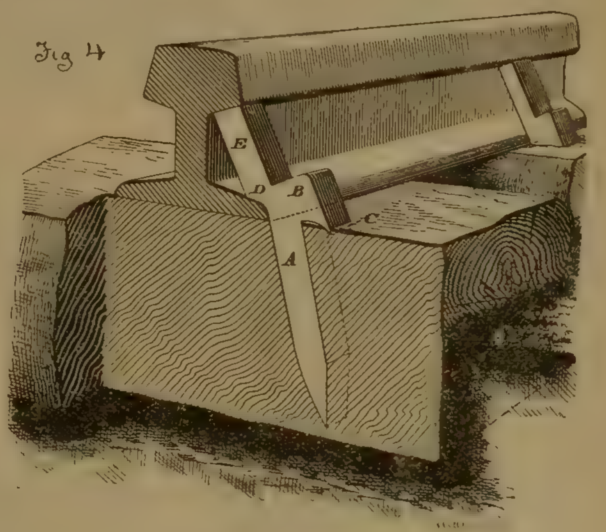
a load variable to but a slight degree, is a condenser at all advisable. So seldom are these conditions realized in practice that probably not one plant in five could be run with this extra mechanism at a profit over and above what could be obtained without it and with a good form of feed-water heater. Repeated expert tests have shown this to be true; and a better proof is the general acceptance of the fact by those most interested—the manufacturers.

In the few cases where it is undoubtedly commercially valuable, the structural disadvantages of the independent condenser has been against it as much as the inefficiency of the independent system.

Recently a combination which incorporates the advantages of both has been designed. It consists of a Dow positive rotary pump, coupled direct to a small Westinghouse engine, as illustrated in the annexed cut, and is briefly a *high-speed independent condenser*, with all the economy of operation found in the *belted* form. With the results indicated by a practical test of this form of condenser in the New England States during the past year, many of the objections to such a plant are removed, and the possibility of economy extended over a greater range of unfavorable conditions.

## A Novel Railroad Spike.

FIG. 4 shows a spike of a new design for which patent No. 462,045 was recently issued to Mr. Daniel Hegarty, of Philadelphia. This invention consists of a spike provided with means for supporting the head of a rail, making the rail solid, and preventing shifting thereof, as will be hereinafter set forth and definitely claimed. In the drawing, which is a perspective view, partly in section, *A* is a spike, on one side of the head *B* of which is a depending pointed or sharpened tooth *C*, and on the opposite side thereof is a shoulder *D*. Rising from the shoulder *D* is an arm *E*, which extends from the head in a direction obliquely toward the rail.




HEGARTY'S RAILROAD SPIKE.

The spike is driven obliquely into the tie, the blows being struck upon the head *B*, and when it is home the shoulder engages with the base of the rail, the tooth enters the tie, and the arm *E* is beneath the head of the rail and in contact with the under side thereof, thus forming a support and brace for said head. As the tooth enters the tie, lateral shifting of the head of the spike is prevented, and as the shoulder interlocks with the base of the rail and the head of the latter is sustained by the arm, as has been stated, the rail is held solidly and well adapted to sustain the strain to which it is subjected by car-wheels on the gauge side.

The spike and its connected parts are made in one piece, thus possessing strength and durability, and constructed of iron, steel or other suitable metal.

## A Large Dry-Dock.

THE largest dry-dock on the Lakes has just been completed by the Detroit Dry-Dock Company at its Orleans Street Yard, in Detroit. It was built by A. J. Dupins as contractor, under the supervision of J. C. Parker, Superintendent of the yard, and cost in all over $200,000. It will take in a loaded ship carrying a cargo of 3,000 tons. In the foundation of the dock over 2,000 piles were driven.

The inside dimensions are: 378 ft. long; 91 ft. wide on top; 78 ft. opening at entrance; 54 ft. opening on miter-sill; 55 ft. wide on floor; 16 ft. 6 in. of water over keel-blocks; 16 ft. 6 in. of water over sill; 4 ft. 6 in. from top of keel-blocks to floor of dock; 20 ft. 6 in. from water-line to floor of dock.

## The Sewall Coupler for Steam Heating.

THE Sewall, which is the original straight-port and insulated steam coupler, is now used by 88 railroads, having a mileage of 43,931 miles in the United States and Canada, and having 8,922 passenger cars. The long and wide use of this coupler is the best demonstration of its merits in actual service. The cuts herewith published show its construction.

The passage for steam is practically straight, and thoroughly unobstructed by strainers, springs, diaphragms, gasket retainers or acute angles. All metallic parts of the coupler are made of malleable or wrought iron or steel.

On the coupler-head are placed a tooth and space, in proper position (shown at *H* and *I* in fig. 1), to serve the double pur-

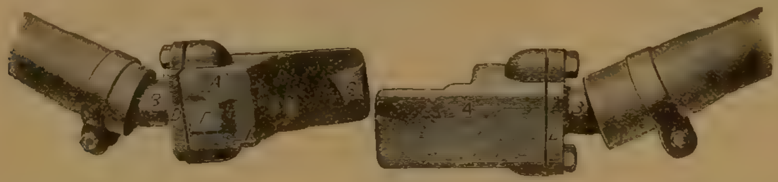


Fig. 1.

Fig. 2.

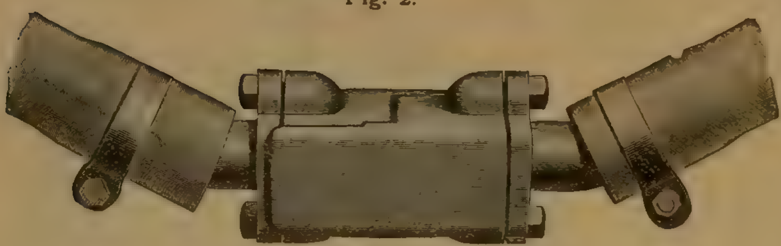


Fig. 3.

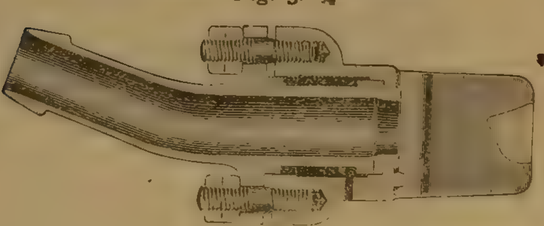


Fig. 4.

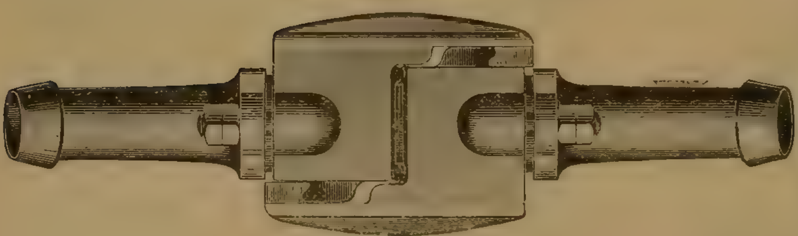


Fig. 5.

THE SEWALL COUPLER FOR STEAM HEATING.

pose of a guide for the interlocking devices when being coupled, and also to retain the coupler-heads in proper relation while uncoupling. The locking features are constructed upon carefully calculated epicycloidal curves, thereby drawing the gaskets together in a direct line through the locking devices, and hence gravity tightens the faces. That the coupler is automatic in uncoupling is due to the curvature of the hose nipple (shown in fig. 4), the center line of draft being brought above the center line of pressure as soon as hose begins to approach a horizontal position. The gaskets are composed of peculiarly treated rubber, and have sufficient elasticity, as well as strength, to form a perfect and durable steam joint. The gasket is tightly pressed upon the inner face of the coupler-head by the hose nipple being forced against it, and is held rigidly in place by studs and nuts shown in fig. 4. A new gasket is readily put in place when occasion requires.

Condensation is provided against by insulating the hose-nipple or steam tube by a dead air space completely surrounding the steam tube within the coupler-head. This is the only steam coupler now in use which makes any endeavor to insulate the metallic parts exposed to the atmosphere, and so to prevent unnecessary condensation.

The parts of the Sewall coupler are but five—the coupler-head, the nipple, the gasket, the studs, the nuts. It has no need of springs, traps, diaphragms or movable steam faces to make it sufficient. The Sewall has no movable parts, and hence should be durable.

Other advantages claimed are that it is steam tight; it hangs below the air coupling; it uncouples automatically; it couples easily; it is most widely used; it is not a cheap coupling, but is the most economical.

The standard measurements adopted for the application of the Sewall coupler throughout the United States and Canada are as follows: Train-pipe to terminate on right-hand side as one looks out of the car and at a distance of 13 in. from the buffer face; termination of train-pipe to be also 12 in. to the right of the center line of the car, and 32 in. from the top of rail; hose to be 23 in. long; support chains from center of eye plate to center of hook on standard passenger cars to be 34 in. long; train-pipe to be of 1½-in. pipe, terminating with 1½-in. standard thread 45° ell; offset in train-pipe to be as shown in blue prints; 45° ell to be screwed on train-pipe so as to point slightly toward center line of car.

The careful observance of these standards has made possible the present wide interchange of several thousand cars already equipped with the Sewall coupler.

## A Pneumatic Hoist.

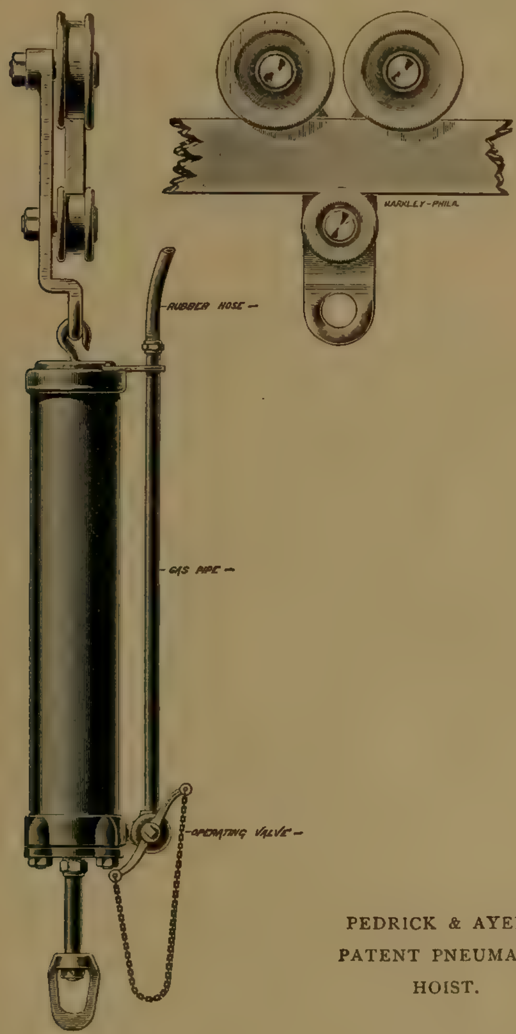
THE accompanying engraving shows a pneumatic hoist intended to take the place of the ordinary chain hoist or block-and-fall for lifting comparatively light loads about machine tools, in shops and similar places. It is, in effect, a simple power hoist, which can be quickly started and stopped by the manipulation of a small valve.

The construction is well shown in the engraving. The cylinder is small, of extra strong wrought-iron pipe, carefully reamed out; to the upper head is fastened an ordinary pipe cap, to which there is attached a hook, by which the hoists can readily be hung to the overhead trolley, and, if desired, the hoist can be transferred to different parts of the shop. The lower head is made of two castings, one of which is screwed to the end of the cylinder, and has a lug to receive a screw end of the valve, which supplies the air for lifting. This prevents the piston from traveling below the air opening. To this lower ring is attached a head which is held in place by four small studs and nuts; this head also contains the stuffing-box for packing around the piston-rod; by this construction the lower head can be readily removed for an examination of the piston and its packing without in any way disturbing the hoist. The piston is of simple design, consisting of a cast-iron head, follower-plate and a leather cup-ring, which nicely adjusts itself to the cylinder and prevents leakage. The lower end of the piston-rod has a swivel which allows the ring to be turned to any desired position in the rod. The piston acts but one way, as it has been found that the weight of the load, or even of the piston-rod and head, is sufficient to allow it to drop when the pressure from the lower end is relieved.

The valve consists of but four parts—a body, valve-stem, cap and small spring to keep the valve-stem in place, which, with the air pressure, keeps the stem in constant pressure against the body. One side of the valve is provided with a lug, by which it is attached to the lower ring of the hoist; the valve requires no packing, and is of such a construction as to be readily

and cheaply repaired, although, after a constant service of over a year, no appreciable wear has been noticed. The parts of the hoist are all strong and substantial; all the parts submitted to strain are steel or wrought iron; the upper and lower heads are of cast iron, as is also the valve, the stem of which is carefully ground to a seat in the valve body.

The lifting capacities of these hoists, when 80 lbs. air pressure is used, are: 3 in. diameter, 450 lbs.; 4 in., 800 lbs.; 6 in., 1,800 lbs.; 8 in., 3,200 lbs.




PEDRICK & AYER'S PATENT PNEUMATIC HOIST.

The power is supplied by an air compressor, one of which is 6 in. to 8 in. in diameter, with a storage tank of about 3 ft. in diameter and 5 ft. long, and will supply sufficient compressed air for 12 to 18 hoists having average use. For special purposes, such as where the hoist is used constantly, a less number can be supplied by a compressor of the above size. Hose is attached to the upper end of the wrought-iron pipe, the length of the hose depending upon the floor area which it is desired the hoist should cover.

The advantages claimed for these hoists are the saving in time and labor over the ordinary block hoist, and the additional amount of work which their use will enable a tool to get through. They are made by the well-known firm of Pedrick & Ayer, of Philadelphia.

## PERSONALS.

John B. Linn, recently City Engineer of Springfield, O., is now connected with the Pittsburgh Bridge Company.

George T. Jarvis is now General Superintendent of the Lake Erie & Western Railroad, succeeding D. S. Hill, resigned.

Clem Hackney, formerly Superintendent of Motive Power of the Union Pacific, is now General Manager of the Fox Solid Pressed Steel Company, of Chicago.

William Hassman has been appointed Superintendent of Motive Power of the Western Division of the Newport News & Mississippi Valley Company's lines.

Charles H. Wiggin has been appointed Master Mechanic of the Concord Division of the Boston & Maine Railroad. He was recently Foreman of the Boston shops.

J. F. Holloway, of New York, was recently elected an Honorary Member of the Civil Engineers' Club of Cleveland, O. Mr. Holloway was one of the founders of the Club, and for three years was its President.

Colonel Peter C. Hains, U. S. Engineers, has been relieved from duty at Washington, and ordered to the headquarters of the Department of Dakota, at St. Paul. Colonel Hains has had charge of the reclamation of the Potomac Flats.

Henry M. Sperry has been appointed General Agent of the Johnson Railroad Signal Company, with office in Chicago. He is an expert signal engineer, and has been for 10 years past with the Pennsylvania Railroad; since 1887 he has been Supervisor of Signals of the New York Division.

J. Madison Porter has been chosen Professor of Civil Engineering in Lafayette College at Easton, Pa. He has been assisting as instructor in that department since the death of Professor Fox. Professor Porter has been for some time connected with the firm of Tippett & Wood at Phillipsburg, N. J.

## OBITUARY.

John Gregory Smith, who died in St. Albans, Vt., November 6, aged 73 years, was Trustee and Receiver of the Vermont Central and afterward President of the Central Vermont Company. He was also for several years President of the Northern Pacific Company. He served two years as Governor of Vermont.

Colonel Samuel S. F. Chalfin, who died in Savannah, Ga., November 1, was a graduate of West Point, and served during the Mexican War. After that he settled in Brooklyn, and was employed for a number of years as a civil engineer. For some 10 years past he has been connected with the City Department of Public Works.

Lewis Lyon, who died in New York, October 29, aged 61 years, had been President of the Third Avenue Railroad Company for 13 years. He first introduced the cable system in New York—the building of the Amsterdam Avenue & 125th Street line being chiefly due to him—and he had only recently secured the adoption of the same system for the main line.

William M. Parker, who died in Manchester, N. H., October 29, aged 70 years, was the first Assistant Superintendent of the Hudson River Railroad. He afterward had charge at different times of the Northern New Hampshire, the Boston, Hartford & Erie, the Connecticut & Passumsic Rivers, and of the Boston & Lowell Railroads, but for some time past has retired from business.

Alfred C. Hobbs, the inventor of the celebrated Hobbs lock, died in Bridgeport, Conn., November 6, aged 79 years. He established a firm in London, while on a visit there in 1851, but afterward returned to this country and was Superintendent of the Howe Sewing Machine Works and later of the Union Metallic Cartridge Works in Bridgeport. He retired from business three years ago.

Colonel John A. Wright, who died in Philadelphia, November 1, was one of the incorporators of the Pennsylvania Railroad Company, and assisted in securing the charter of that company in 1845. He was an officer of the company for a number of years, and was appointed its first Chief Engineer.

He retired from active work a number of years ago, his last active service being as a member of the Board of Abritration chosen by the trunk lines in 1879, the other members being David A. Wells and Charles Francis Adams. Colonel Wright was 71 years old at the time of his death.

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Colonel Samuel H. Lockett died in Bogota, Colombia, October 12. He went there last year as Chief Engineer for the new water works of the city. He graduated from West Point, and served in the Engineer Corps a few years. During the war he served in the Confederate Army, and was later in the Egyptian service for a time. Returning to the United States, he assisted General Stone in putting up the statue of Liberty in New York Harbor, and afterward built up a considerable practice as consulting engineer for water works. For several years past he had spent much time in South America.

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Dr. John Francis Williams, who died in Ithaca, N. Y., November 9, aged 29 years, graduated from the Rensselaer Polytechnic Institute at Troy, and subsequently studied at Göttingen, in Germany. He was for a short time engaged in teaching at Clark University, in Worcester, Mass., and was then appointed Assistant Geologist on the Arkansas State Survey, where he did some excellent work. Last summer he was appointed Assistant Professor of Geology in Cornell University, and had just begun his work there, with excellent prospects of success. Dr. Williams wrote several excellent short articles on geological topics, some of which appeared in the Journal, and his early death has closed a very promising career.

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Moncure Robinson, who died in Philadelphia, November 10, aged 89 years, was born in Richmond, Va., and graduated from William and Mary College when only 16 years old. He began work as an assistant on the first topographic survey made of a line from Richmond to the Ohio River, and was afterward employed on the James River Kanawha Canal. In 1825 he went to Europe and spent three years in study, and in 1828 he was employed by Stephen Girard in surveying some lines in the anthracite coal fields. In 1830 he built the old Clover Hill coal road near Richmond, and afterward made the surveys for the Richmond & Petersburg, the Petersburg and the Richmond, Fredericksburg & Potomac roads.

In 1835 Mr. Robinson removed to Philadelphia, and there he made the surveys for and located the Philadelphia & Reading Railroad from Pottsville to Philadelphia. He was engaged also in the construction of the Chesapeake & Delaware Canal and in some surveys in Georgia. His reputation was such that he was invited to take charge of the building of the first railroads in Russia, but declined. In 1842 he took charge of the building of the dry-dock at the Brooklyn Navy Yard. A few years later he practically retired from the practice of his profession, though he was often called on to act as consulting engineer. He took an active part in the building of the Seaboard & Roanoke and the Raleigh & Gaston roads and their extensions, in which he held a large interest.

Mr. Robinson was an honorary member of the American Society of Engineers and the Engineers' Club of Philadelphia. He leaves five sons and three daughters, the oldest son, John M. Robinson, having been for a number of years President of the Seaboard & Roanoke and its controlled companies.

John Marston Goodwin, who died in Sharpsville, Pa., October 27, aged 57 years, was born in Boston, where his father was for a number of years Superintendent of the Massachusetts General Hospital. When only 15 years old he entered upon work as Assistant in the engineer corps of the Vermont & Canada Railroad, and he was later employed on the Vermont Central and some lines in Eastern Canada. In 1856 he was employed on the La Crosse & Milwaukee, and later was on the Michigan Southern & Northern Indiana. During the war he was engaged with Colonel Thomas A. Scott and Peter C. Watson in some mining enterprises in Kentucky. When Mr. Watson was made President of the Erie, Mr. Goodwin was for a time his Assistant, and did excellent service. Later he was Chief Engineer of the Sharpsville Railroad, which was located and built under his charge. He was employed as consulting engineer on several enterprises, and was recently made a member of the Pennsylvania Ship Canal Commission. He made the surveys for the line which the Commission proposed to the Pennsylvania Legislature, and was actively engaged in that work at the time of his death. He died of brain fever after a short illness. He leaves a wife and several children.

John M. Goodwin was a man of extraordinary attainments, and very few men possessed such an extensive range of knowledge. Unlike most men of whom this can be said, however, his knowledge was exact and particular in almost every case. He would have succeeded excellently as a Mechanical Engineer, but preferred civil engineering, although his talent led him to invent several devices, including a dump car which has come into extensive use, and a rotary engine, upon which he was engaged recently in the intervals of his canal work; he also devised a system of cable towing for canals. He was a frequent contributor to technical journals and society proceedings, but although always willing to impart knowledge to others, he was very reluctant to engage in any extensive literary work. With his great fund of general knowledge, power of acquiring information—and perhaps in consequence of this—he was somewhat discursive in temperament, and at times seemed to lack the faculty of concentration. Many men of his powers would have acquired a large fortune; but what has been called the instinct for gain seemed to be lacking in him, and although he had been engaged in many important works, and had done a large amount of work in the course of his life, he died a poor man.

He had a large acquaintance among engineers and others, and was almost universally liked. Few men could be his enemies long, although he never hesitated to speak plainly or attempted to conceal his opinions.

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## PROCEEDINGS OF SOCIETIES.

**The Committee on Safety Appliances.**—Pursuant to notice, the Committee on Safety Appliances, appointed by the last Conference of Railroad Commissioners, held a meeting in New York, November 10, all the members being present except Mr. Hill, of Virginia. A number of railroad officers and others were present, including representatives of several associations of railroad employés, and of the Master Car-Builders' and Master Mechanics' Association. The Chairman of the Committee read a number of replies received from railroad companies, showing that less than 15 per cent. of the freight cars in the country were fitted with automatic couplers, and only about 10 per cent. with train-brakes. Only a small proportion of the railroads favored national legislation.

Colonel Haines, President of the American Railroad Association, stated that the hook coupler or the M. C. B. standard had been adopted by that Association, and was being introduced as fast as possible. Representatives of the Master Car Builders' and Master Mechanics' Association spoke in favor of the adoption of the M. C. B. standard, and thought that the general use of automatic couplers would lessen the dangers to trainmen. Representatives of the Switchmen's Mutual Aid Association, however, made some strong addresses in favor of the old link-and-pin type of coupler, and stated that so far the introduction of automatic couplers had very much increased the danger of accident, owing to the difficulty of coupling between the automatic and the old style drawheads. This opinion was endorsed by some of the railroad officers present.

The session was continued into the second day. The Committee has not announced its intention, but it is understood that the members will feel bound to prepare a bill for submission to Congress regulating the subject.

**American Society of Mechanical Engineers.**—The annual meeting began in New York, November 16. The first session was held in the evening of that day, and was chiefly occupied by the annual address of the President, Mr. Robert W. Hunt, who chose for his subject the American Rolling Mill, making a very interesting paper.

On Tuesday morning a business session was held when the report of the counsel was read, showing the Society to have received $19,843 during the year, the balance remaining in the hands of the Treasurer being only $2. The report made a detailed statement in relation to the house in New York. Reports were also received from the Committee on Standards, and the Committee on Standard Methods of Tests, and the Committee on Standard Pipe Flanges.

It was resolved to raise the initiation fee to $25 and the dues to $15 per year. The tellers announced that the ballots had been canvassed, and the following officers were elected: President, Charles H. Loring, Brooklyn, N. Y. Vice-Presidents, G. I. Alden, Worcester, Mass.; E. F. C. Davis, Richmond, Va.; Irving M. Scott, San Francisco, Cal. Treasurer, William H. Wiley, New York. Managers, James M. Dodge, Philadelphia, Pa.; Robert Forsyth, Chicago, Ill.; Jesse M. Smith, Detroit, Mich.

It was also announced that a large majority had voted in favor of holding the spring meeting in San Francisco. The afternoon was devoted to excursions to various points of interest, and in the evening a session was held, at which several papers were read and some of the topical questions propounded were discussed.

On Wednesday no sessions were held, the day being given up to visits to the Brooklyn Navy Yard and other points of interest, the evening being spent by part of the members at the Star Theatre and the remainder at the American Institute Fair.

On Thursday a morning session was held, at which several papers were read and topical questions discussed. The afternoon was left open for excursions to various points, and in the evening a public reception was held at the Lenox Lyceum, at which a large number of members and guests were present.

The concluding session for the reading of papers and discussions was held on Friday morning, November 20, and the convention then adjourned.

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**American Association of Irrigation Engineers.**—This association was formed at the recent irrigation convention in Salt Lake, Utah, and will have its headquarters in that city for the present.

The officers chosen are: President, A. D. Foote, Boise City, Idaho. Vice-President, G. G. Anderson, Denver, Col. Secretary and Treasurer, C. L. Stevenson, Salt Lake City, Utah. Directors, L. G. Carpenter, Fort Collins, Col.; J. B. Greene, Denver, Col.; H. I. Willey, San Francisco.

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**Train Dispatchers' Association.**—The officers of this Association are: President, R. B. Woolsey, Terre Haute, Ind.; Vice-President, H. A. Mace, Dunmore, Pa.; Secretary and Treasurer, C. E. Case, Toledo, O.; Executive Committee, M. C. Coyle, J. F. Mackie, R. S. Quigley and W. W. Olcott; Committee on Train Rules and Orders, J. S. Mackie, W. H. Graves, J. H. McEwen, J. A. Weldon and W. M. Eggleston.

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**New England Railroad Club.**—At the regular meeting, November 10, a by-law was adopted providing that, beginning with January, regular meetings shall be held once in two months instead of monthly.

The subject for discussion was Care of Steam-Heated Cars at Terminal Points, upon which Messrs. Lauder, Marden and Adams were the principal speakers. The general method adopted is to heat cars at terminal points from stationary boilers either erected for the purpose or used for other purposes. This, it was stated, becomes a considerable tax upon railroads having many branches and terminal points like most of the larger New England roads.

A short debate on the subject of Joint Inspection of Freight Cars followed, the general opinion being apparently against the general inspection.

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**Engineers' Club of Philadelphia.**—At the regular meeting, October 17, the following members were elected: J. F. Stevens, Carl G. Barth, Edward G. Bennett, George H. Perkins, A. G. Menocal, B. S. Lyman, and F. M. Smith.

Resolutions were adopted for the appointment of a Committee of three to bring the subject of Land-locked Navigation between the Delaware River and Florida before the commercial bodies of the various seaboard cities. The Committee consists of Captain S. C. McCorkle, Foster Crowell and Rudolph Hering.

Hon. B. E. Fernow, Chief of the Forestry Division in the Department of Agriculture, described the tests of timber now being made by the Department. The matter was discussed, and the Secretary was directed to forward a letter to the Department expressing the Club's appreciation of the importance of these tests.

Mr. F. H. Lewis presented a paper on Soft Steel in Bridges. The use of soft steel, on at least an equal footing with wrought iron and medium steel, was advocated, and numerous tests of the material, in support of the position taken by the author, were presented.

The subject was discussed by letter by Mr. C. S. Sims, Jr., and Mr. Charles S. Churchill, and verbally by Messrs. Henry B. Seaman, E. E. R. Tratman and James Christie.

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At the regular meeting, November 7, Mr. Max Livingston read a paper on Solid, Liquid and Gaseous Fuel, referring to their relative values. This was discussed at some length, members bringing up several cases of the use of oil and other liquid fuels.

A paper by Mr. W. W. Thayer on Street Paving was read. This was discussed at considerable length by members present, and in addition some written discussions were read. Some of the criticisms stated a fact which is apparent in almost all cities, and that is, that the trouble is not so much with the kind of pavement used as with the poor foundations, the general habit in this country being apparently to consider that good pavements will do on any kind of foundation. Many interesting facts were brought out in the discussion. One member stated that with the old cobble-stone pavement formerly used in Philadelphia, 1,500 lbs. was considered a load for one horse, while to-day it is very common to take 8,000 lbs. with a pair of horses. The subject was not completed, but was continued until the next meeting.

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**Civil Engineers' Club of Cleveland.**—At the regular meeting, November 10, reports were received on new quarters for the Club, and also on the recent visit to the works of the Walker Manufacturing Company.

Mr. John Walker gave a description of some of the large pieces of work now building for cable railroads, and also for the construction of the melting furnaces in their foundry, which had been very successful.

Mr. E. P. Roberts read a paper on the Incandescent Electric Lamp from the standpoint of the manager and customer. The paper was accompanied by charts showing the light of the lamp with different currents. This paper was briefly discussed.

Professor C. S. Howe read a paper on a New Method of Computing Areas in Land Surveying, which he claimed was shorter than those in general use. This also was discussed.

The tellers reported that J. F. Holloway had been elected an honorary member, and William H. Starr, Albert W. Johnston and J. C. Beardsley active members.

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**Engineers' Club of Cincinnati.**—At the September meeting of the Club Mr. A. O. Elzner read a paper under the head of Engineer and Architect. He called attention to the intimate relations between the professions and the difficulty sometimes to know where to draw the line, and noted in this connection that many of the magnificent ancient works of so-called architecture certainly combined in their construction the ability of both the engineer and the architect. The professions must evidently depend upon each other for assistance in the carrying out of many of the large works of the present time, else an architect must be an engineer or an engineer combine the qualifications of the architect. This is illustrated in the fact that the Board of Architects of the World's Fair Buildings at Chicago simply design and determine exteriors for the various buildings, while the work of preparing detailed plans, specifications, the necessary calculations, and the construction are all in the hands of a separate Engineer Department. Many of the improvements and much of the economy in the construction of the present day are due to the assistance of each profession to the other. Incidental to the paper was a reference to and general description of the construction of the tall modern buildings of iron or steel framing encased in brick or terra cotta. Mr. Elzner exhibited the plans of the Neave Building, in Cleveland, which is of such construction.

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**Southern Society of Civil Engineers.**—At the October meeting, held in Savannah, Ga., a paper on Railroad Location was read by M. H. Lynch, of Fort Worth, Tex., and discussed by members present.

The annual meeting will be held in Jacksonville, Fla., January 18, 1892.

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**Southern & Southwestern Railroad Club.**—The regular meeting was held in Atlanta, Ga., November 19. The first subject for discussion was Uniformity in Locomotive Performance Sheets, including methods of collecting and computing data. This was opened by Mr. James Meehan and was continued by a number of members.

The second subject was Repair Work on Large Systems—whether it was most economical to concentrate the work as much as possible in one large shop, or to conduct it in several shops distributed over the line. This subject was opened by a paper read by Mr. W. H. Thomas, of the East Tennessee, Virginia & Georgia.

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**Western Railroad Club.**—Mr. Waldo H. Marshall has been chosen Secretary in place of Mr. W. D. Crosman, who has resigned. Mr. Marshall was until recently Secretary of the Southern & Southwestern Railway Club.

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## NOTES AND NEWS.

**Military Ballooning.**—The Paris correspondent of *Nature* writes: "The new ballooning plant for the use of the French Army arrived recently at Arras from the works of Chalais-Meudon, and differs principally from the old apparatus by the exclusive employment of hydrogen gas compressed to 200 atmospheres in steel cylinders, for inflating the balloon. As such cylinders only weigh 6 kilos to each cubic meter of gas,

the aerostatic plant is considerably lightened, since the preparation of the gas on the spot would have necessitated the transport of 9 kilos of chemical meterials for each cubic meter of gas produced, without taking carriages and receivers into consideration. Another advantage which the new system possesses consists in the extraordinary short time—15 minutes—required for inflating the balloon. Moreover, water can in this case be dispensed with, while with the old system it was necessary to have a supply constantly on the spot. The whole operation of inflating the balloon is rendered extremely simple, and no preliminary operations are required. The balloon can therefore be, so to say, most rapidly mobilized, and thus every tactical opportunity can be utilized, since the balloon can be got ready at any moment and in any place. Eight carriages have been constructed at Chalais-Meudon, each of which is capable of conveying eight cylinders, which are provided with a brass closing valve, constructed by Major Renard. Two carriages fully laden with cylinders are required for the inflation of the balloon. To compress the gas a pump is employed, which can compress 150 cubic meters of hydrogen under a pressure of 200 atmospheres in one hour. It has been stated that the gas used for inflating the balloon can be recovered and again compressed in the cylinders, but this is incorrect, for the compression of the gas requires considerable time, as well as very powerful and ponderous stationary machinery, which could not accompany the Army during a campaign. An aerostatic park is to be attached to each army corps and placed under the direct authority of the head of the general staff, and one to each fortified place designated by the Minister of War. The ascents hitherto made have sufficiently proved the excellent material and construction of the balloons, which may perhaps be destined to neutralize to some extent the advantages claimed for smokeless powder, since they can be so rapidly utilized and enable the occupants of the car to discover the position of the enemy at a great distance."

**Electric Lighting by Water Power.**—At St. Brieux, Cotés du Nord, France, two 1,300-light Thomson-Houston alternators are driven by two Hercules turbines of the vertical type, one of 125 H.P. and the other of 150 H.P. An interesting characteristic of this plant is that the two alternators are run in multiple upon the same circuits. The distance from the central station to the center of distribution is 8.4 miles, and the pressure employed is 2,000 volts. It is interesting to note that the wire employed to convey the current for 2,600 sixteen-candle-power incandescent lamps 8.4 miles is in this case only 0.31 in. in diameter.

At Guatemala, Central America, a combined arc and incandescent plant has been operated by means of water power since 1887. A part of the plant, consisting of two 1,300-light alternators, is 3¾ miles distant from the city. The dynamos are driven by a countershaft from a 21-in. Rodney-Hunt turbine of 250 H.P. The remainder of the plant, comprising seven 45-light 2,000 C.P. arc dynamos and three 18-light arc dynamos, is 7½ miles away from the city, and receives its power from a 15-in. double Rodney-Hunt turbine of 260 H.P.

The city of Puebla, Mexico, possesses an electric lighting plant which is in many ways remarkable. Two hundred arc lamps of 1,200 C.P. are run by four 50-light arc dynamos in a station about 13 miles from the center of the town, where the River Atôyac furnishes power for a 200 H.P. Leffel double turbine. Each of the four circuits is about 26 miles in length, and consists of a No. 4 insulated wire. The dam and all the masonry connected with the station itself are built of fine cut stone, forming probably one of the most substantial and best built structures in Mexico. As the station is so far from the town and in the midst of a country infested with bandits, the Government finds it necessary to maintain at all times a guard, consisting of seven soldiers, to protect the station from injury by marauders.

A contract recently entered into by the Thomson-Houston International Company provides for a plant to be worked by water power in the town of Piracicaba, San Paolo, Brazil. The system will probably comprise 50 arc lamps of 1,200 C.P. each, and about 2,000 incandescent lamps of the alternating system. In this plant the power will be situated quite close to the lighted district, about one mile away.—*Electrical Engineer.*

**Industrial Accidents.**—The International Congress which met at Berne, in Switzerland, in October, to consider the question of Industrial Accidents—that is, the accidents to which the workingman is exposed in, and in consequence of, his work—adopted the following resolutions:

"*Prevention of and Payment for Accidents.*—It is an imperative duty to prevent by all possible means industrial accidents and sicknesses resulting from work, and to pay for those which do occur. 1. As to preventive measures it is desirable to combine individual action, that of associations and of the State. 2. As to payment of damages or benefits, the best plan is some form of insurance association, to be organized in each country, the details to be arranged to meet local requirements. 3. In such associations it would seem best to separate accidents slight in their nature, and to carry them by means of the ordinary benefit associations. 4. Where it is considered desirable to establish some form of insurance—pension or annuity—for old age or permanent disability, it might be combined with the insurance against serious accidents and professional maladies.

"*Statistics.*—The Congress, being convinced of the value of statistics when properly collected and classified so as to admit of comparison, requests that efforts be made in all countries to collect statistics of industrial accidents and diseases in a systematic way, and with as much detail as possible. The Executive Committee is instructed to prepare forms for the collection of international statistics, and to submit the same to the next meeting of the Congress. The Committee is advised to consult with the International Statistical Institute, the Committee of the International Congress of Hygiene and Demography and other allied bodies, in order to secure a proper understanding as to the basis of these statistics, such as the proper nomenclature for different professions, causes of death and disease, and similar matters."

**A Steam Jet Ventilator.**—The production of an induced current by a steam jet for ventilating purposes has been studied by Mr. Granger, who has designed the jet shown in the annexed

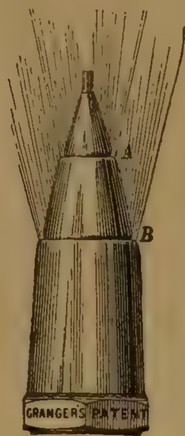



FIG 1.

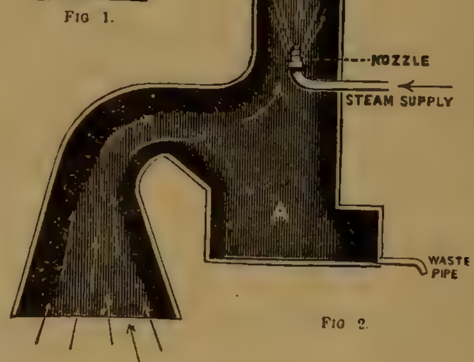
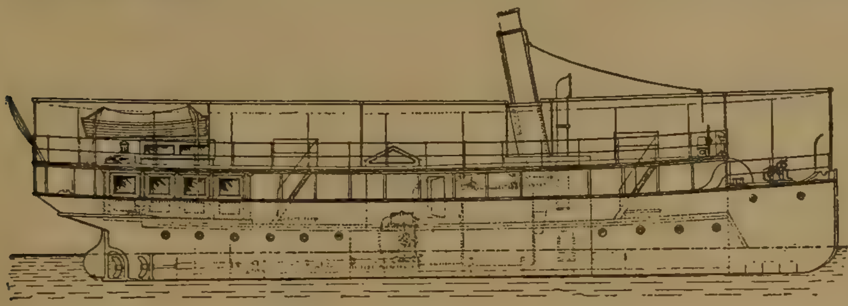



FIG 2.

illustrations, and has applied it in practice for the extraction of foul air and the supply of fresh, the latter result following as a consequence of the former. Fig. 1 shows the nozzle, in which there are two annular orifices, $A$ and $B$ (adjustable in area) for the issue of steam, the smaller jet supplementing the hollow portion of the larger, so that the two combined form practically a solid jet, but consume very much less steam than any solid jet. Fig. 2 shows the general method of producing air currents. $B$ is a shaft containing a nozzle, which latter, when supplied with low-pressure steam, induces a strong air current through $B$ in the direction of the arrows. Thus, if the total outlet areas of the nozzle be adjusted to one-sixth of a square inch, it is stated that the air current through $B$ will be no less than from 70,000 to 80,000 cub. ft. per hour, or say sufficient to ventilate a room containing 50 persons, allowing the very ample volume of 25 cub. ft. per minute for each person. The small pit or chamber $A$ collects any water arising from condensed steam or rain, and which ultimately escapes by the waste pipe. A special feature of the system is the employment of low-pressure steam, which experiments have shown to be a great economic advantage.—*Iron.*

**A Triple-Screw River Boat.**—The accompanying sketches show a triple-screw river boat, designed for work on shallow streams in India, by Mr. Hugh Dunsmuir, of Govan, Scotland. The boat is 90 ft. long, 20 ft. beam and 11 ft. 6 in. deep; she draws 32½ in. with coal and passengers only, and 38½ in. with a deck load of freight.



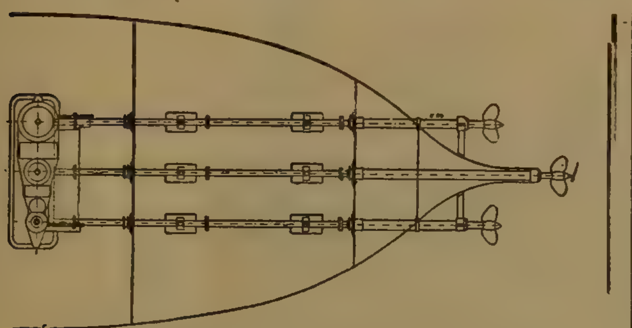


Fig. 1 shows a side elevation of the boat, and fig. 2 a plan of the stern, with the arrangement of screws. All three shafts are driven by one triple-expansion engine with cylinders 9 in., 14½ in., and 27¼ in. in diameter and 10-in. stroke; in ordinary service this will run about 300 revolutions. The engine is so arranged that one cylinder acts on each screw, the three cranks being coupled by a rod in such a way as to counterbalance the large cylinder. This arrangement is fully described in the JOURNAL for May last, page 232.

The screws are three-bladed, 31 in. in diameter and 47 in. pitch. Steam is furnished by a tubular boiler 9 ft. in diameter and 9 ft. long, with two corrugated fire-boxes. The boat has made a speed of 11 miles an hour.

**Uniform International Time.**—The International Geographical Congress, held at Berne last August, adopted a memorial in favor of an international time system similar to that by which railroad time is now regulated and changes made in the United States and Canada. This system, which has been much discussed in Europe, was generally approved in the Congress, in which 43 nations were represented.

The Congress recommended that a conference be called, to be held in Berne, in which the different nations should be represented by accredited delegates; the Conference to be empowered to adopt a primary meridian as a starting-point and to adjust the details of the system, the meridians of change of hour, etc. The uniform time system will then be adopted by railroads and vessels throughout the civilized world.

**The Most Northern Railroad in America.**—The line now extending furthest north in North America is the Calgary & Edmonton Railroad, completed in August last, which carries travelers from the Canadian Pacific Railroad at Calgary to Edmonton on the North Fork of the Saskatchewan, in latitude 53° 30′. This is the top notch of railroading on this continent, 800 miles north of New York, and at least 300 miles higher up in the world than the line of railroad now building across Newfoundland. In Europe there are railroads further north, and in Sweden there is a little railroad which crosses the Arctic Circle.

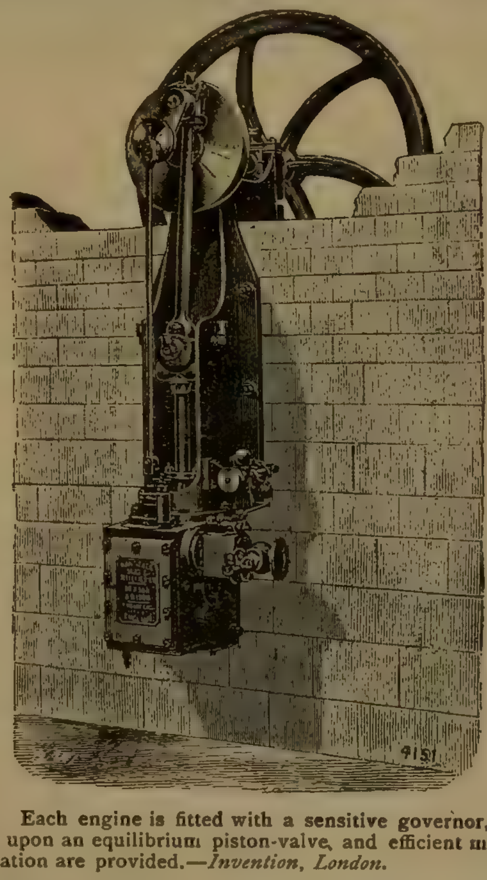
This new railroad in Canada will play a large part in the fortunes of the northwestern country, for in many respects the North Saskatchewan Valley is inviting and abounds in resources, and before a great while there will be quite a large population there. The Saskatchewan will be bridged and the railroad extended at least 50 miles beyond Edmonton. The town of Edmonton is 2,200 ft. above the sea, and though it is so far north, crops are as fine in that region as in most parts of the continent.

With the aid of this railroad it is now possible to travel by steam all the way from the City of Mexico to the shores of the Arctic Ocean at the mouth of the Mackenzie River, except for short portages from the Saskatchewan to the Athabasca River, and around two series of rapids in that river and the Mackenzie. The Hudson Bay Company's steamer runs for many hundreds of miles on the middle and lower Mackenzie River.—*Goldthwaite's Geographical Magazine.*

**An Improved Wall Engine.**—The cut given herewith shows a strong and handy form of wall engine made by the firm of Ransomes Sons & Jeffries, of Ipswich, England. The uses of this class of engine are well known.

The engine being fixed to the end-wall of the building, the crank-shaft occupies a position at right angles to the face of the wall, and any stress due to the vibration of the engine is transmitted to the wall in a direction parallel with its length, in the direction in which the wall is best suited to withstand such stress. These engines, therefore, obtain a distinct advantage over the usual form of wall engine, which is bolted to one of the side walls of the building, in which latter type the crank-shaft being parallel to the face of the wall, the stress is transmitted to the wall in a direction at right angles to its length. Where the speed of the shop shafting does not correspond to the speed of the engine, the latter may conveniently be arranged to drive the shafting by belt.

The engine frame, with the guide-bars, is in a piece with one of the plummer blocks, and is bolted to a casting which forms the outer plummer block, and which in some cases is brought up so as to form a box above the crank-shaft, thus supporting the wall over the engine. The center casting, at its further extremity, is rigidly secured to a large wall plate arranged on the opposite side of the wall to the engine cylinder; the bolts securing the engine to the wall passing through this plate, any possibility of either plummer-block springing is thus avoided. These engines are sometimes made with a double crank, so that the power can be taken off from both ends of the crank-



shaft. Each engine is fitted with a sensitive governor, acting direct upon an equilibrium piston-valve, and efficient means of lubrication are provided.—*Invention, London.*

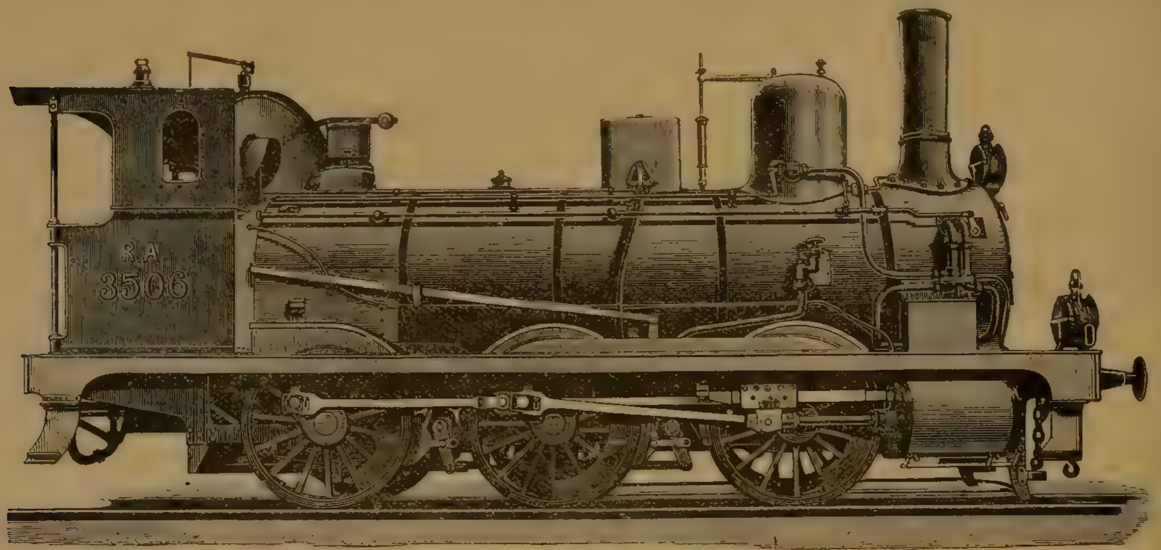
**The Fastest Train.**—The new train of the New York Central & Hudson River Railroad, which, it is claimed, is the fastest regular train ever run, leaves New York at 9 A.M. and makes the run to Buffalo in 8 hours 41 minutes; an average

speed of 50.6 miles an hour, without allowing for stops. The train stops at Albany, Utica, Syracuse and Rochester, and deducting the time required for these stops, the actual running is done at the rate of 52 miles an hour.

Somewhat better average time is made by some of the trains between Baltimore and Washington; but this is doubtless the best regular time ever made over so long a distance.

**An Italian Freight Engine.**—The accompanying illustration, from the London *Engineer*, shows a freight engine recently built for the Adriatic Railroad in Italy by the shops of G. Ansaldo & Company, at Sampierdarena. The engine is of a type very commonly used in Europe, having six wheels coupled and no truck. The cylinders are outside, with the steam-chests inside.

The boiler, which is built to carry 150 lbs. working pressure, is 54 in. diameter of barrel, and has 185 tubes 2 in. in diameter and 13 ft. 8 in. long; the total heating surface is 1,170 sq. ft. The cylinders are 17.75 in. in diameter and 25.6 in. stroke; the driving-wheels are 54 in. in diameter.




The total weight ready for service is 92,500 lbs. The tender weighs 58,000 lbs. full; the tank carries 2,400 galls. of water. The engine is somewhat unsightly to us, owing chiefly to the number of pipes and fittings carried outside the boiler.

**Use of Water under Pressure in Founding Dock Walls.**—In the execution of the new harbor works at Calais, France, the foundations of the quay-walls for the outer harbor have been sunk by means of water injected under pressure, a method which has been attended with the most satisfactory results as regards economy and rapidity of execution, and which M. Bailly, who describes it in a paper recently presented before the Société des Ingenieurs Civils at Paris, believes to have been there introduced for the first time.

The quay-walls are founded in a very fine and movable sand, easily loosened by water; and, after some preliminary trials, which proved that piles could easily be sunk by a jet of water directed beneath them, the experiment was extended to the sinking of great blocks of masonry built upon a timber curb. The experience gained in these further trials was so far reassuring that the system was then adopted on a large scale for the sinking of the quay foundations and also for the driving of piles and sheeting.

The foundations are carried down to a depth of 8 to 11 meters below the present bottom of the basin, provision being made for the subsequent dredging of the outer harbor to allow vessels of the deepest draft to lie alongside at low water.

The quay is founded upon a series of square wells built of rubble masonry upon a curb or base of strong concrete. The outer surfaces of these square cells are vertical throughout, while the central shaft is octagonal in form and splayed outward at the base, so that the walls come to a sort of cutting-edge, which, however, has a width of 1 meter, corresponding with the width of the concrete shoe. In general, the wells are 8 × 8 m. in outside dimensions, the octagonal shaft being 4 m. in diameter, and the wells are sunk side by side in the line of the quay wall, leaving spaces of 0.4 m. between them. In sinking the series of wells, the first, third, fifth, etc., are first got down, and then the intervening ones, and lastly the intervening spaces of 0.4 m. are excavated by the water-jet and filled with concrete, which dovetails the whole series together by filling two pairs of grooves, which had been formed in the sides of the contiguous masonry wells.

The process of sinking one of these wells is as follows: The masonry cell is first built *in situ* to a height of 4 m., and the well is sunk by injecting water under the cutting-edge by means of wrought-iron pipes carried down through the central shaft, and splayed outward so as to direct the jet upon the sand beneath the cutting-edge. Thus loosened, the sand is brought up by a centrifugal pump, whose suction-pipe descends in the center of the shaft, and draws sand and water from the bottom of the conical cavity, which is gradually formed by the disengagement of the sand around its sides. The pumping-machinery for the sinking of the wells is mounted on wheeled trucks, which run upon a line parallel to the line of wells. For the water-jets, four Tangye pumps are employed, and are supplied with steam from two small vertical boilers, while the centrifugal pump is drive by a separate portable engine and boiler. The wrought-iro pipes, by which the water-jets are delivered, are 12 in number, and are divided into four groups, the three pipes of each group being connected with one of the Tangye pumps by flexible rubber tubes. The jets are so directed around the cutting-edge as to excavate the sand regularly and to correct any tendency of the well to deviate from the vertical in sinking, and in general the deviations are almost insensible.

Some difficulty was at first experienced in the working of the centrifugal pump, owing to the settlement of the sand in suspension in the suction-pipe, which tended to choke the valve at the foot of the pipe whenever the pumping was temporarily stopped. This was remedied, however, by attaching to the valve-box one of the wrought-iron pipes through which a jet of water was at such times delivered into the valve-box just above the valve, and by means of the circulation of a continuous stream of water the deposit of the sand was prevented.

On the average the sinking of a well to a depth of 4 to 4½ m. was accomplished in 12 to 14 hours, which is equivalent to about 20 cubic m. of excavation per hour.

When the well had been sunk to a depth of 4 m., bringing its top to the level of the ground, the masonry was carried up for a further height of 4 m., and the operation of sinking was then resumed.

In a bed of clay the operation is more difficult and much more tedious; but the system was successfully employed to sink through beds of about 1 m. in thickness. It was also applied to the sinking of wells of smaller dimensions, 4½ × 4½ m. and 4 × 4 m. In these cases the rate of sinking in sand was much faster, and it became more difficult to prevent the well from deviating from its true position.

**Electric Lighting of Trains.**—One of the trains used in the fast express service between Frankfort and Berlin is now lighted by electricity. Each carriage has two storage batteries, and the lights are on two distinct circuits, so that if one of the batteries should fail or be removed for renewal, one-half the lights will remain. The storage batteries have a capacity of 200 ampère-hours each, and are specially constructed so as not to be disarranged by the uneven motion of the cars. Each battery runs four 8-candle-power lamps in the compartments and one 5-candle lamp in the saloon. The batteries weigh about 660 lbs. each.